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VINTAGE STUDY 1984 DEPARTMENT OF THE ARMY INDUSTRIAL

PLANT EQUIPMENT (IPE)(U) ARMY INDUSTRIAL BASE

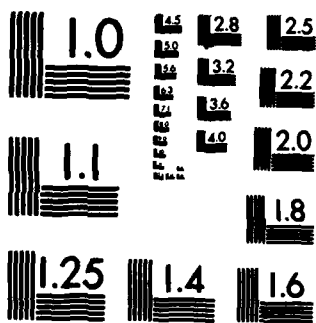
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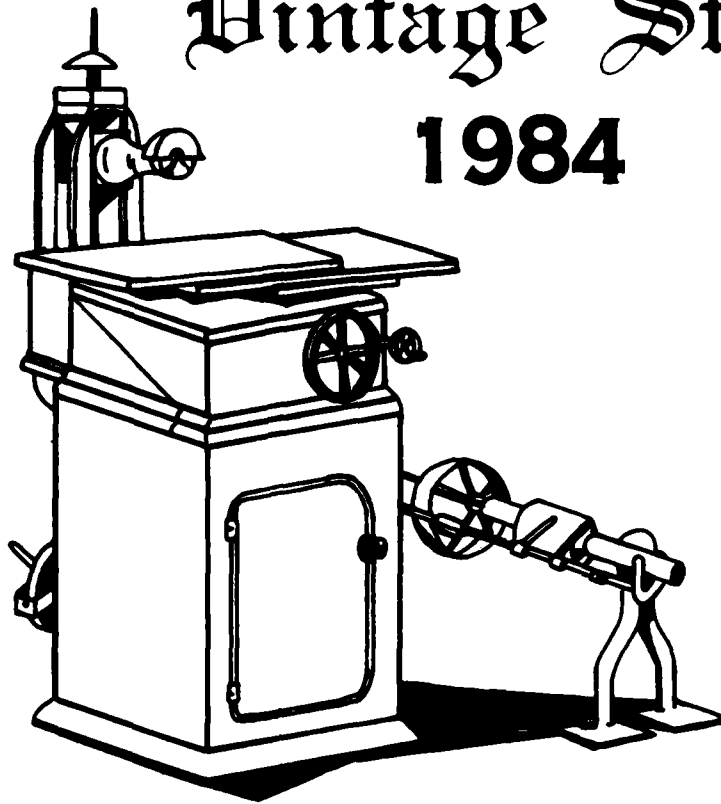


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# Vintage Study 1984



## DEPARTMENT OF THE ARMY INDUSTRIAL PLANT EQUIPMENT (IPE)



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STUDY

the Army  
Equipment

BY  
Kotecki

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Arsenal  
nois 61299

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## PREFACE

This study was conducted in compliance with paragraph 5-2c(6), AR 700-90. It is an analysis of Department of the Army industrial plant equipment, active and inactive, based on year of manufacture. A comparison of active Government equipment with private industry is made based on three age groups: 0-9 years old, 10-19 years old, and 20 years or older. The equipment status within the US Army Materiel Development and Readiness Command (DARCOM) is presented for five types of IPE for the major subordinate commands and laboratories and centers. The vintage (age distribution), quantity and percent exceeding useful service life are portrayed for each type. The status of numerical control (NC) equipment is presented showing the classes, quantity, use, and trends of the inventory.

## VINTAGE STUDY

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## INTRODUCTION

This study is an analysis of Department of the Army industrial plant equipment (IPE) based on year of manufacture. Five types of IPE are considered: metalcutting, welding, metalforming, heat treating/furnaces, and mechanical testing/measuring equipment. Illustrations of each type and the selected Federal Supply Classes (FSC) are contained in Appendix A. The age of the equipment is classified by sorting it into three age groups: 0 to 9 years old, 10 to 19 years old, and 20 years or over. On this basis, Government equipment is compared with private industry. This comparison provides a means to evaluate whether the acquisition of IPE within the Department of the Army is keeping pace with private industry. A comparison of equipment age with useful service life is also made.

The DIPEC SP-57 Report, dated 30 December 1983, The Central Inventory of IPE Report as of 30 December 1983, and the DIPEC SP-50 Report as of 27 January 1984 served as the source documents for Government equipment. Industry data was obtained from the Eleventh, Twelfth, and Thirteenth Inventories of Metalworking Equipment published in 1973, 1978, and 1983 respectively, by the American Machinist Magazine, a McGraw-Hill publication.

Equipment age is not necessarily the best or only criteria to determine usefulness or capability. Other factors such as use and maintenance strongly influence a machine's serviceability. However, equipment age does provide a convenient yardstick by which a comparison can be made.

It is reasonable to assume that production equipment used by private industry is subjected daily to essentially constant service, necessitating earlier replacement. On the other hand, much of the Government equipment is used intermittently. Generally, equipment of a more recent year of manufacture possesses improved operating characteristics, and it follows that the newer equipment possesses improved production capabilities. But, items of equipment with an older year of manufacture may perform very satisfactorily for a given, specific purpose.

This study is not concerned with all these detailed considerations, but concentrates on equipment age only.

## SECTION I

### DEPARTMENT OF THE ARMY

The Department of the Army (DA) inventory of industrial plant equipment (IPE) consists of 50,028 items with an acquisition cost of \$1.628 billion.

The status of the Department of the Army inventory is shown in Figure I-1. The total inventory is characterized by small changes with a decreasing trend except for 1978 and 1979. The increase during these years is attributed to the transfer of IPE from the USN as part of the single manager for conventional ammunition.

The large decrease in active IPE in 1974 reflects the reduction of production to support the war in Vietnam. The corresponding increase in inactive IPE reflects the retention of much of it in plant equipment packages (PEP's). The noticeable increase of inactive equipment in 1978 was caused by the transfer of USN PEP's to the Army as part of the single manager for conventional ammunition. The trend since 1979 has been characterized by increases in active IPE and decreases in inactive IPE.

The US Army Materiel Development and Readiness Command (DARCOM) controls 93 percent of the items, representing 97.5 percent of the acquisition cost of the Department of the Army (DA) inventory. As shown in Figure I-2, DARCOM is clearly the major user of IPE within DA.

In view of this, the items controlled by DARCOM can be considered representative of DA.

#### ACTIVE EQUIPMENT

Most of the equipment controlled by DARCOM, 29,888 items or 64.3 percent, is active. The quantity and percent exceeding useful service life for selected types of this equipment is shown in Figure I-3.

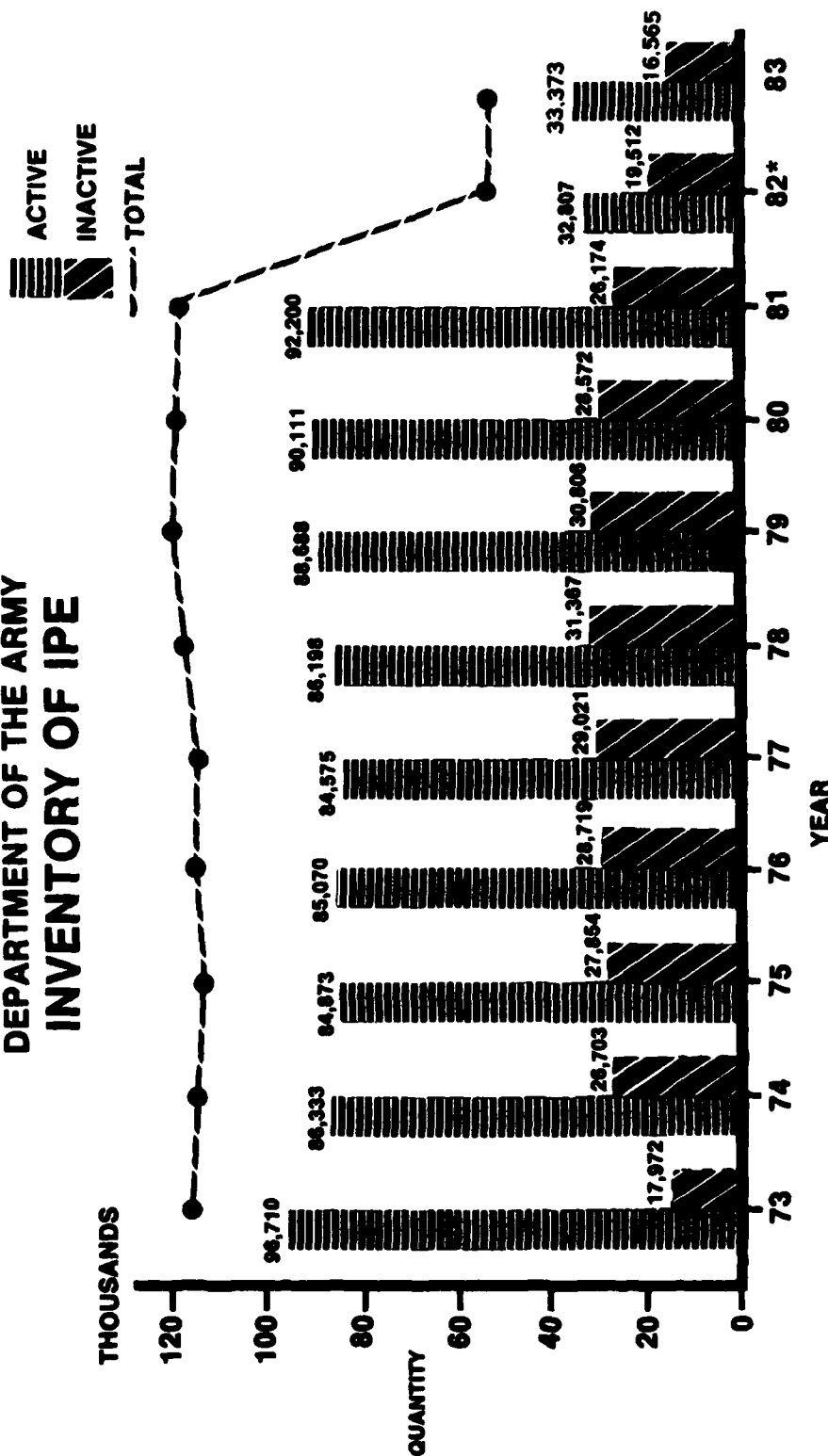
The figures continue to be unfavorable. The percent varies from 29 percent for welding equipment to 63 percent for metalforming equipment. In 1988, four years from now, the percent exceeding useful life will vary from 44 percent for heat treat and furnaces, to 69 percent for metalforming. Metalcutting and metalforming equipment have the highest percent exceeding useful service life. This is significant because of the relatively higher cost of these items. Metalcutting equipment, with 7,796 items, is the type with the greatest number exceeding useful service life; metalforming equipment is a distant second with 1,570 items, and mechanical testing and measuring equipment is third with 796 items.

The vintage (age distribution) of active equipment is shown in Figure I-4. Metalforming and metalcutting equipment are the oldest with 67 percent of the items 20 or more years old. Welding equipment is the newest with 250 items, or 46 percent, less than 10 years old.

#### INACTIVE EQUIPMENT

The vintage (age distribution) of DARCOM inactive equipment is shown in Figure I-5. As might be expected, the inactive equipment has an older age profile than does the active equipment. Metalcutting equipment is again the oldest with 8,111 items, or 89 percent in the 20 year and over age group. The percentage of metalforming equipment, 20 years old or older is the same as metalcutting equipment, but far behind in quantity with only 1,865 items. Mechanical testing and measuring equipment has a younger profile with 16 percent, or 58 items, less than 10 years old, and 52 percent, or 195 items, more than 20 years old.

# DEPARTMENT OF THE ARMY INVENTORY OF IPE



TOTAL 114,682 113,036 112,727 113,789 113,596 117,565 119,494 118,683 118,374 52,319 49,938

SOURCE: DA CENTRAL INVENTORY OF INDUSTRIAL PLANT EQUIPMENT  
AS OF 30 DEC 83

NOTE:  
#DECONTROL OF NUMEROUS ITEMS WAS  
RESPONSIBLE FOR THE ABNORMAL  
DROP OF THE INVENTORY

FIGURE I-1

# INDUSTRIAL PLANT EQUIPMENT



NOTE: DATA IS AS OF 3 DEC 83.

FIGURE I-2

# ACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE DARCOM

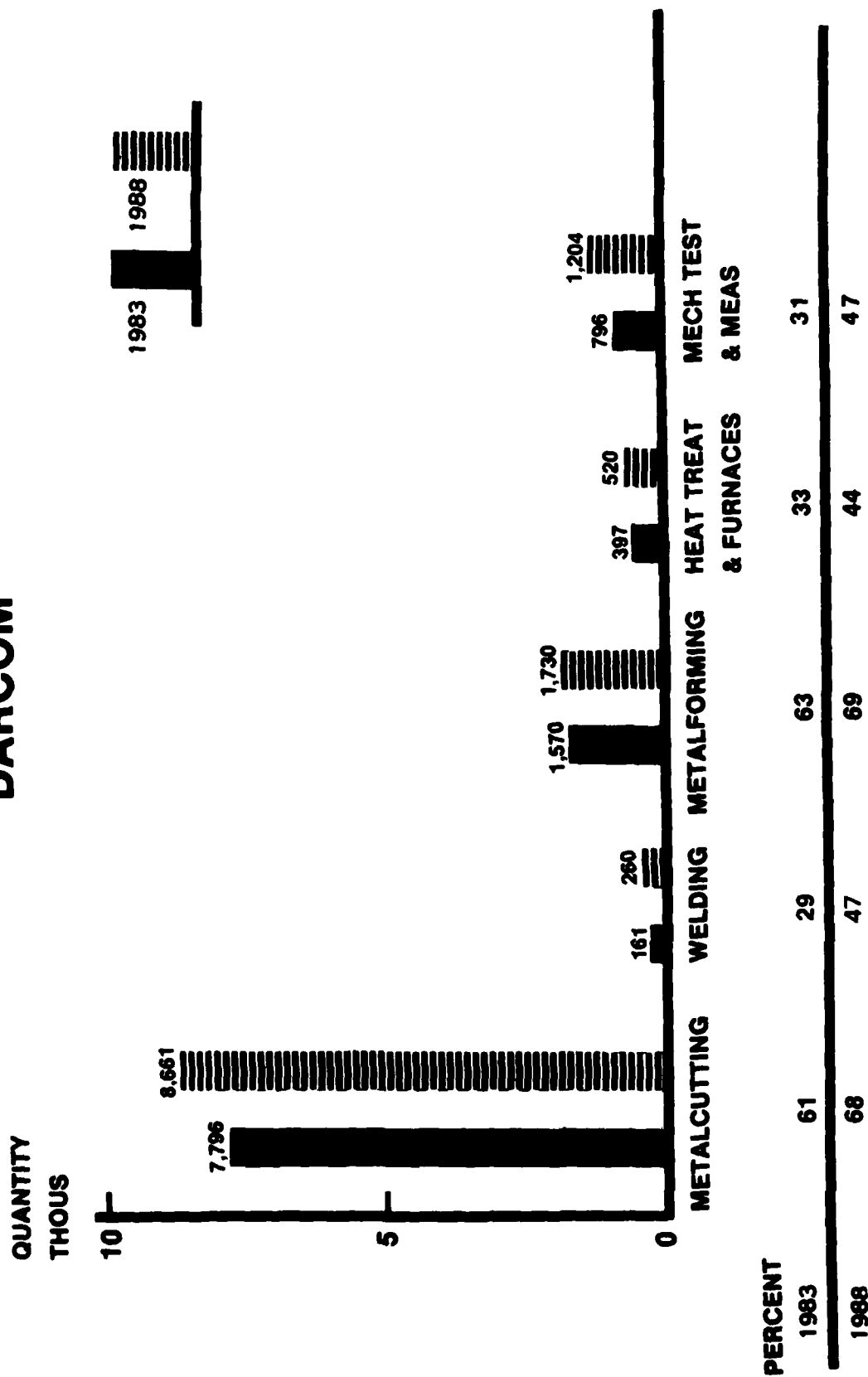


FIGURE 1-3

# ACTIVE EQUIPMENT VINTAGE DARCOM



FIGURE 1-4

# INACTIVE EQUIPMENT VINTAGE DARCOM

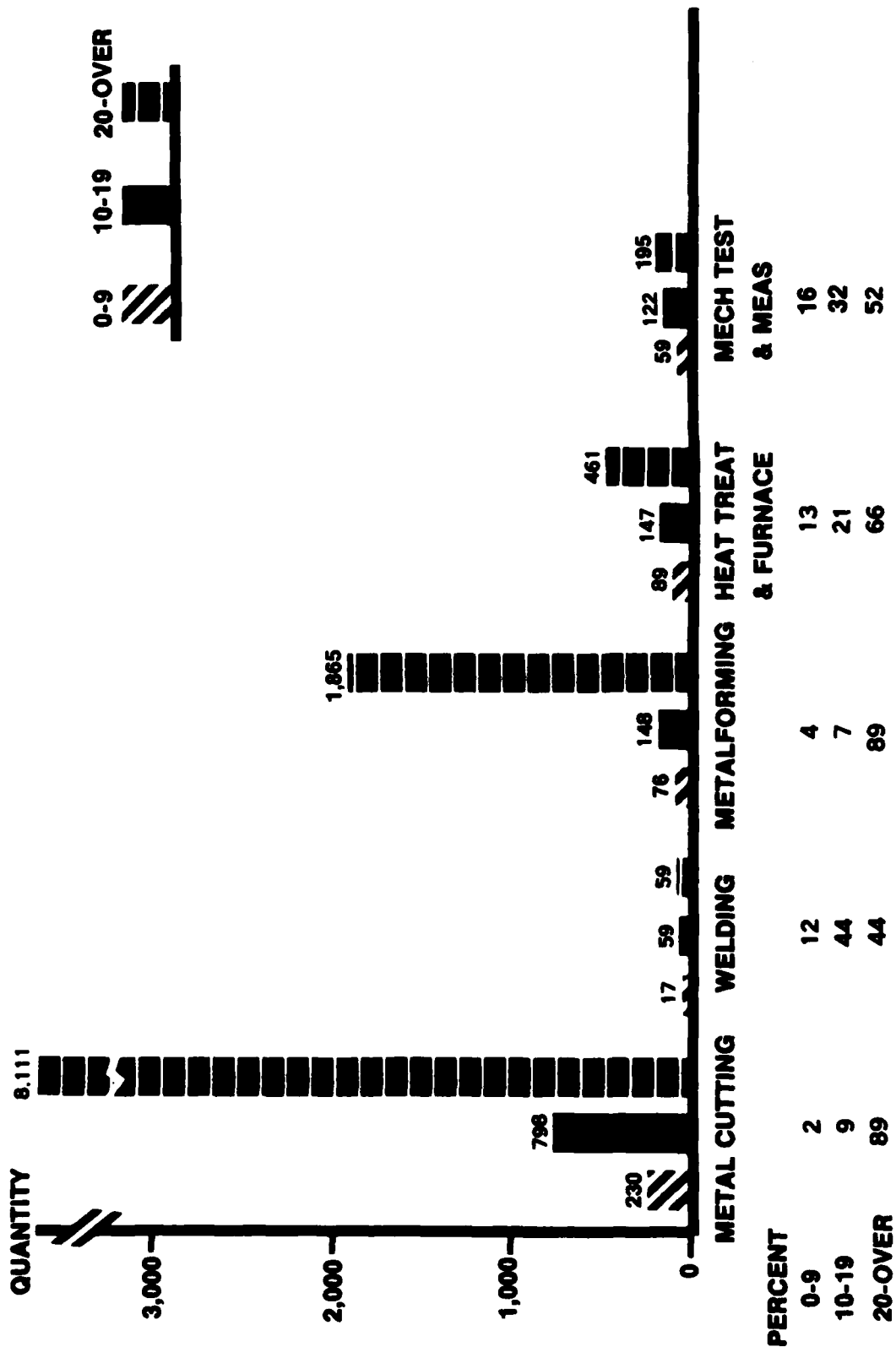


FIGURE I-5

## SECTION II

### DARCOM vs. INDUSTRY

An age comparison of DARCOM and private industry equipment is shown in Figure II-1. The data for DARCOM were obtained from previous Vintage Studies. Private industry data were obtained from the Eleventh, Twelfth, and Thirteenth Inventories of Metalcutting Equipment, published in 1973, 1978, and 1983 respectively, by the American Machinist Magazine, a McGraw-Hill publication.

#### METALCUTTING AND METALFORMING EQUIPMENT

The age profile of DARCOM equipment reflects a replacement level that has not kept pace with the aging of the inventory.

Private industry, on the other hand, exhibits a relatively consistent investment in replacement of equipment. As a result, the equipment operated by private industry has a younger more favorable age profile than the equipment available to the Army. Private industry takes greater advantage of the improved operating characteristics and production capabilities of newer equipment.

#### WELDING/JOINING EQUIPMENT

Private industry and DARCOM equipment exhibit similar status for this type. The shorter useful life which requires earlier replacement seems to be a major reason for this similarity.

#### CURRENT STATUS

A comparison of the current status of DARCOM equipment with private industry equipment is shown in Figure II-2. The age profile of DARCOM equipment continues to be older than to that of private industry. The percentage of DARCOM metalcutting and metalforming equipment 20 years old and over is about double that of private industry. The profile of welding/joining equipment for DARCOM and private industry is reasonably similar but the comparison is still unfavorable for DARCOM.

#### TRENDS

Private industry appears to have slowed their investment in equipment replacement. A definite decrease in newer equipment, 0-9 years old, and an increase in older equipment, 20 years and older, is evident. In spite of this the Army is still in an unfavorable position compared to private industry.

# DARCOM AND INDUSTRY AGE COMPARISON

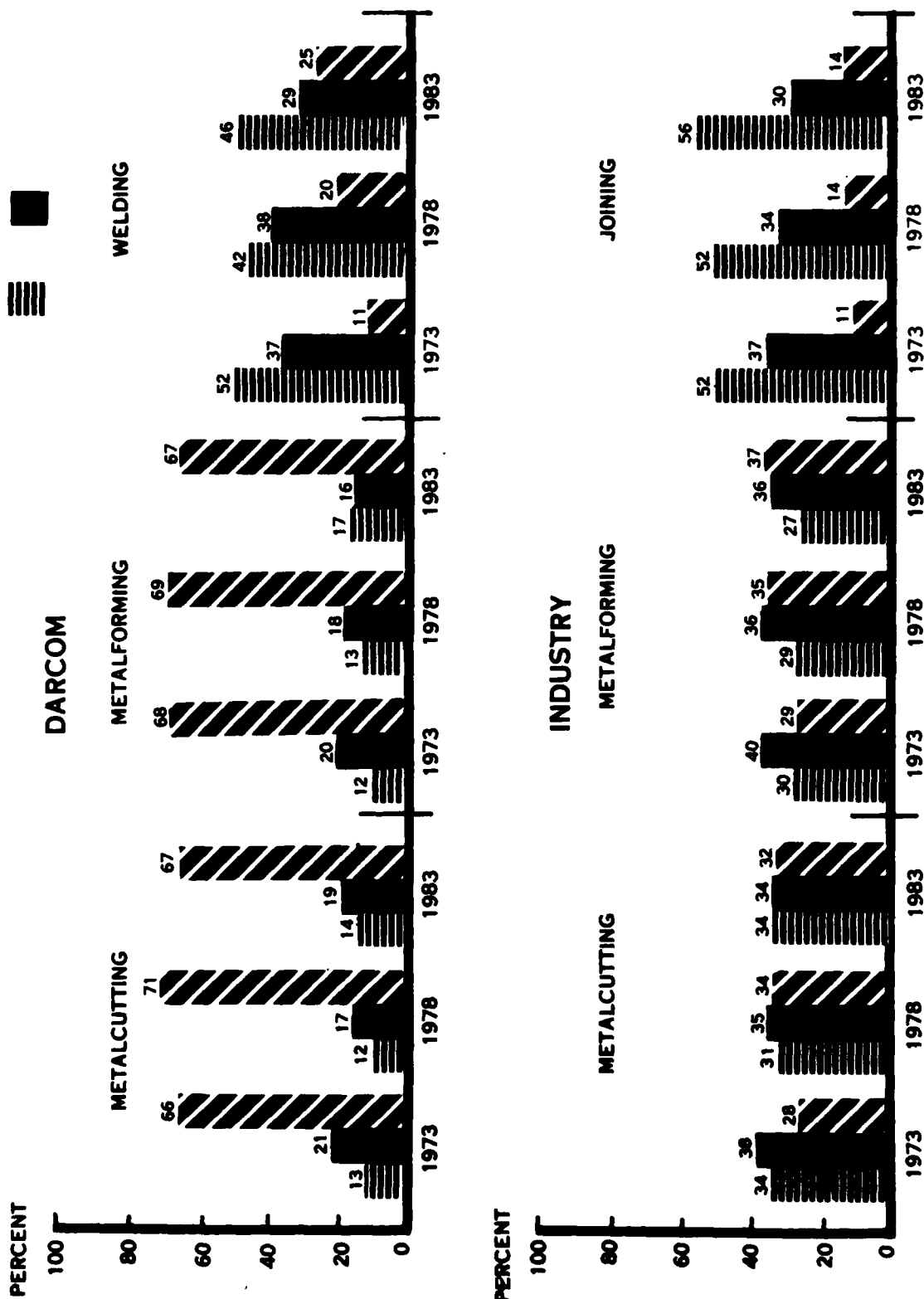


FIGURE II-1

# **DARCOM AND INDUSTRY AGE COMPARISON**

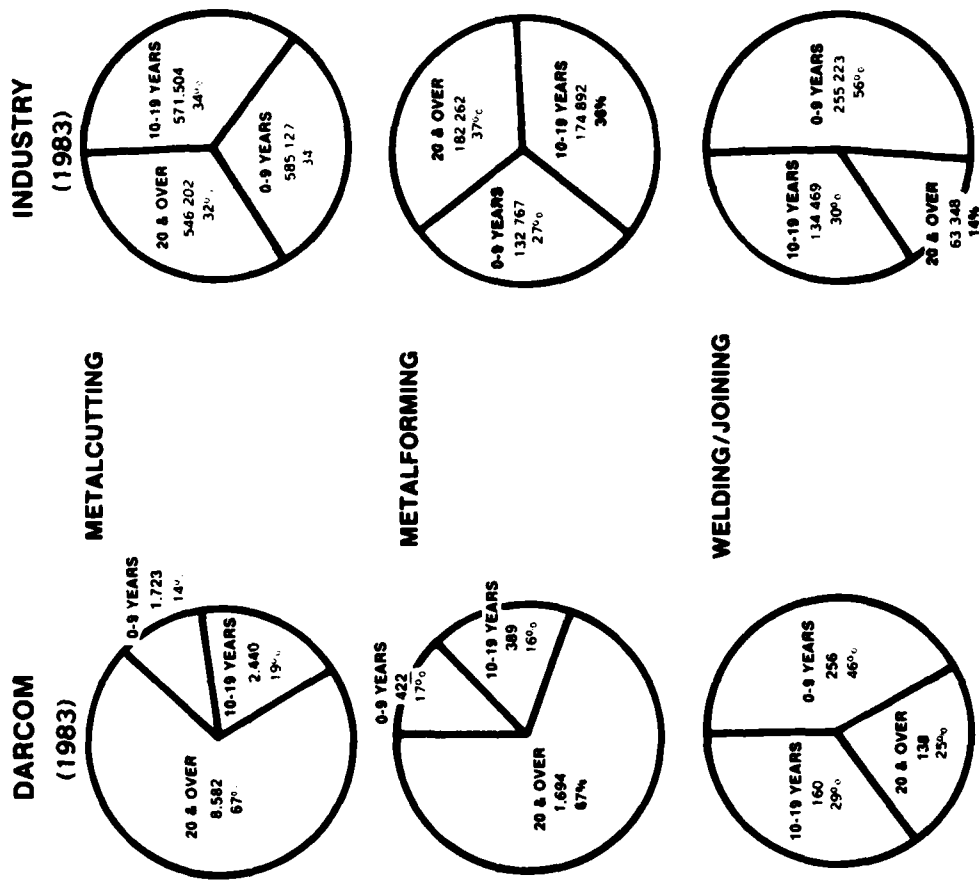


FIGURE II-2

## SECTION III

### EQUIPMENT STATUS WITHIN DARCOM

This section presents the status of each of the five types of IPE for the major subordinate commands (SUBMACOM's) and laboratories and centers within DARCOM. The age distribution (vintage) and the quantity and percent exceeding useful service life are portrayed for each type.

The service life data was calculated by DIPEC based on the useful service life contained in AR 700-43 for each class of equipment within each type. These detailed service life listings were averaged for each type to facilitate data assembly.

### ACTIVE EQUIPMENT

Age Distribution (Vintage). The age distribution for each of the five types of equipment is shown in the following figures:

<u>Type</u>	<u>Figure</u>	<u>Page</u>
METALCUTTING	III-1	3-2
WELDING	III-2	3-3
METALFORMING	III-3	3-4
HEAT TREAT AND FURNACES	III-4	3-5
MECHANICAL TESTING AND MEASURING	III-5	3-6

The age distribution of active DARCOM equipment is influenced greatly by the type of the equipment.

Metalcutting and metalforming equipment are the oldest, most of it over 20 years old. This is true regardless of which command owns it.

Welding equipment, because of its shorter life, is newer with most of the equipment less than 20 years old.

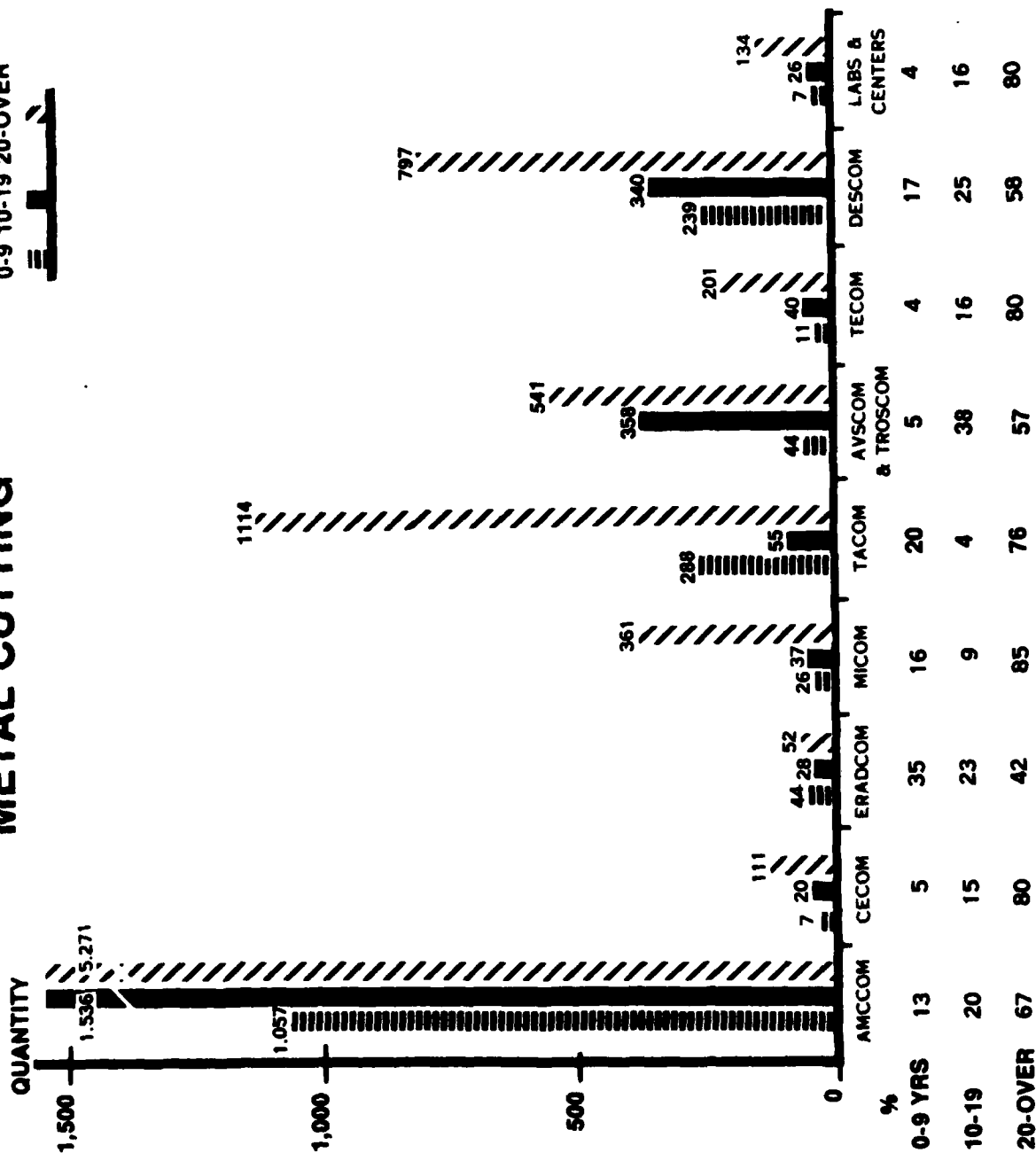
Heat treating equipment and furnaces are more evenly distributed with respect to age. ERADCOM has the most favorable distribution with 56 percent, or 10 items, less than 10 years old; and only 5 percent, or one item, over 20 years old. TECOM has the most unfavorable distribution with 65 percent, or 9 items, over 20 years old.

Mechanical testing and measuring equipment is generally less than 20 years old. AMCCOM, with 1254 items, is by far the greatest user of this type of equipment.

Useful Service Life. The quantity and percent of each of the five types of equipment that exceed useful service life are shown in the following figures:

# ACTIVE EQUIPMENT VINTAGE METAL CUTTING

AGE GROUP  
0-9 10-19 20-OVER



# ACTIVE EQUIPMENT VINTAGE WELDING

AGE GROUP  
0-9 10-19 20-OVER

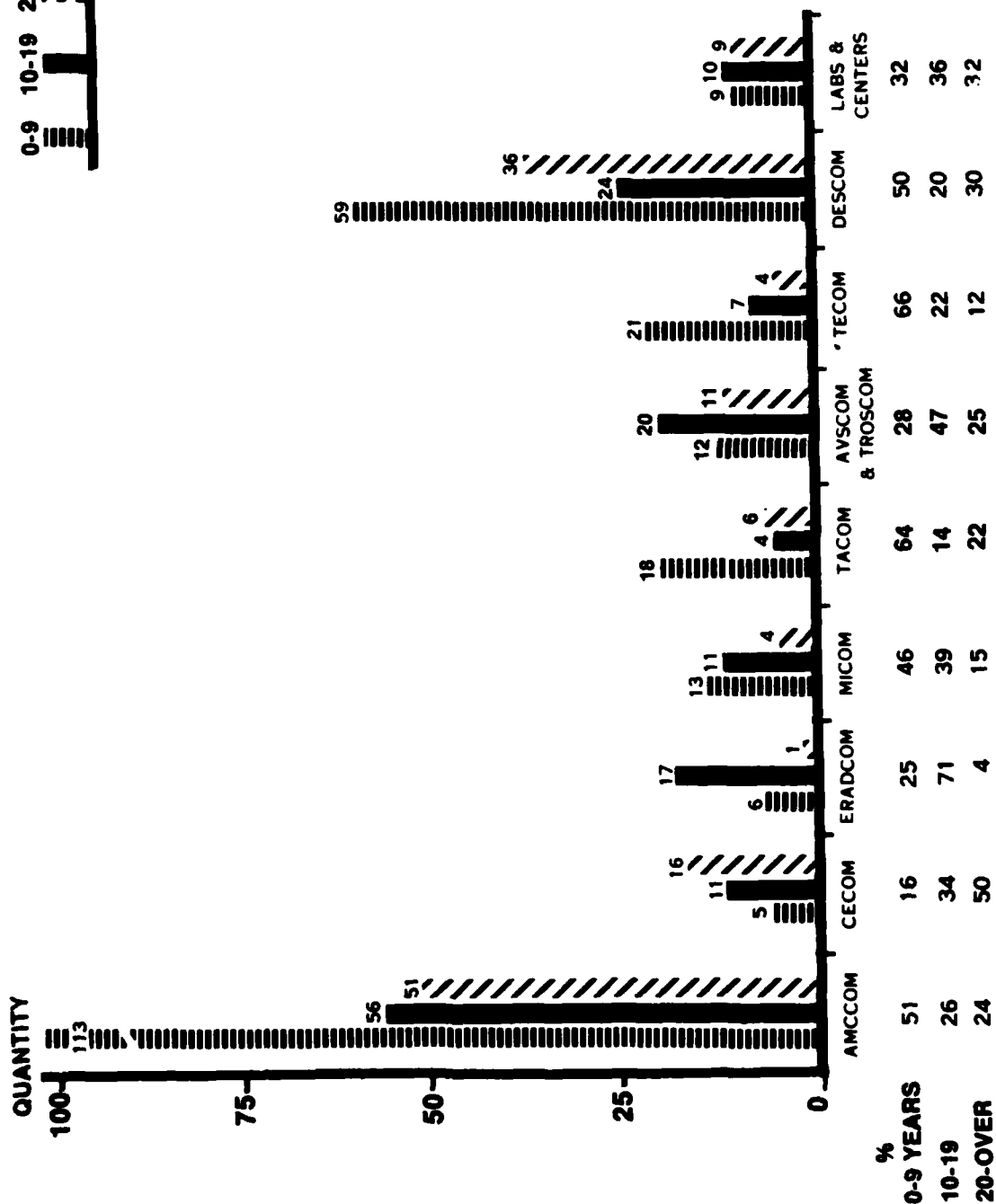


FIGURE III-2

# ACTIVE EQUIPMENT VINTAGE METAL FORMING

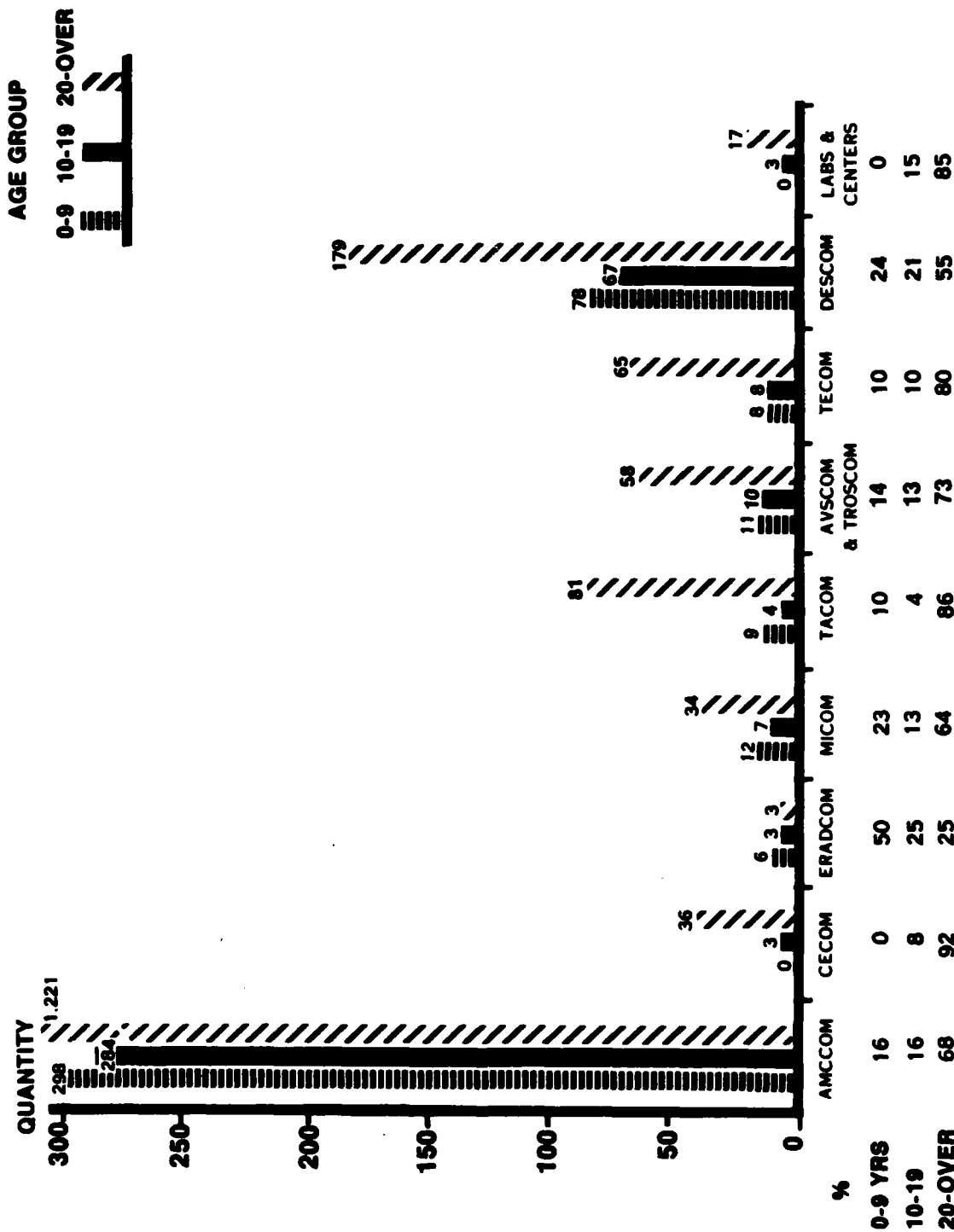


FIGURE III-3

# ACTIVE EQUIPMENT VINTAGE HEAT TREAT & FURNACES

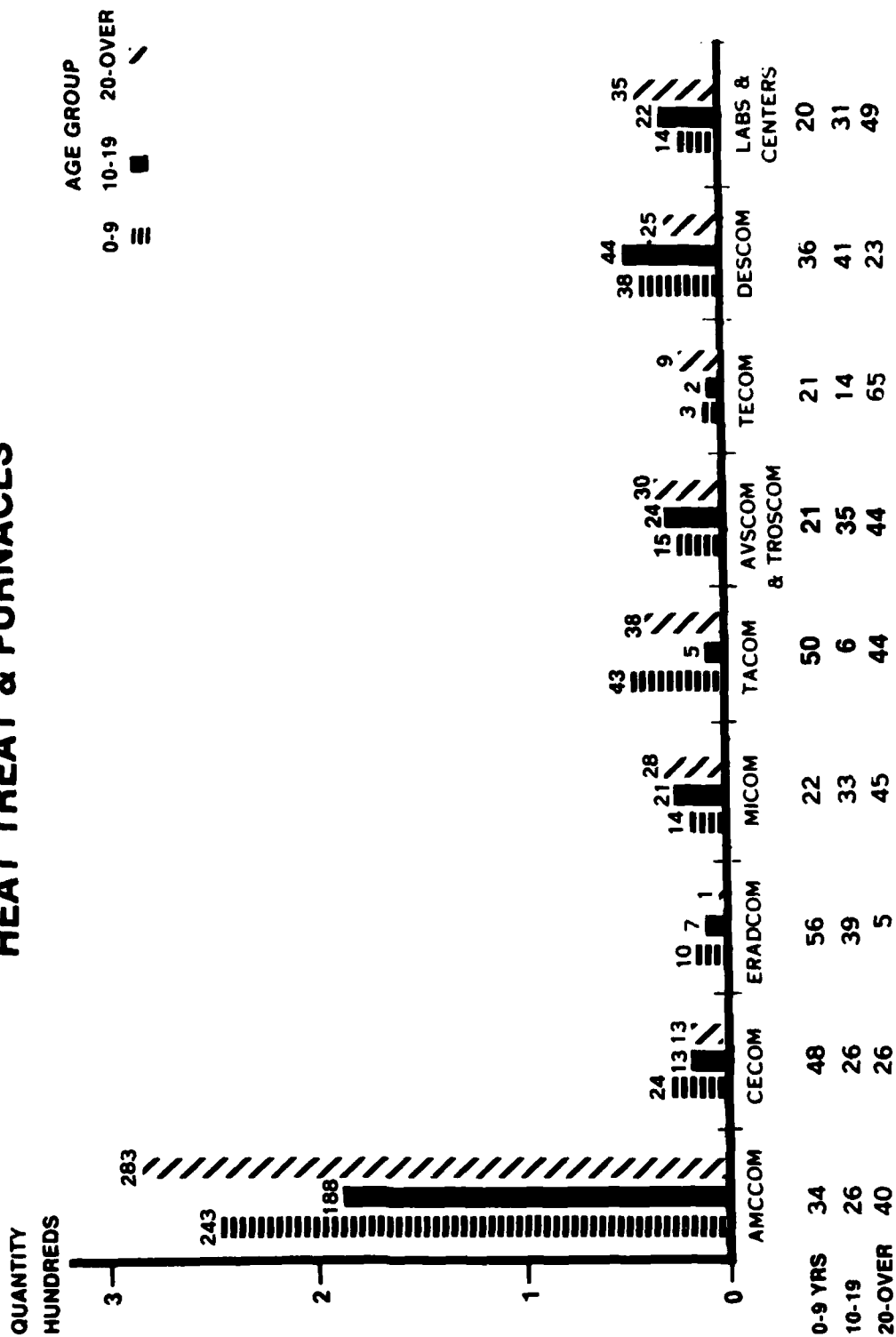


FIGURE III-4

# ACTIVE EQUIPMENT VINTAGE MECHANICAL TEST & MEAS

AGE GROUP  
0-9 10-19 20-OVER

■ ■ ▨

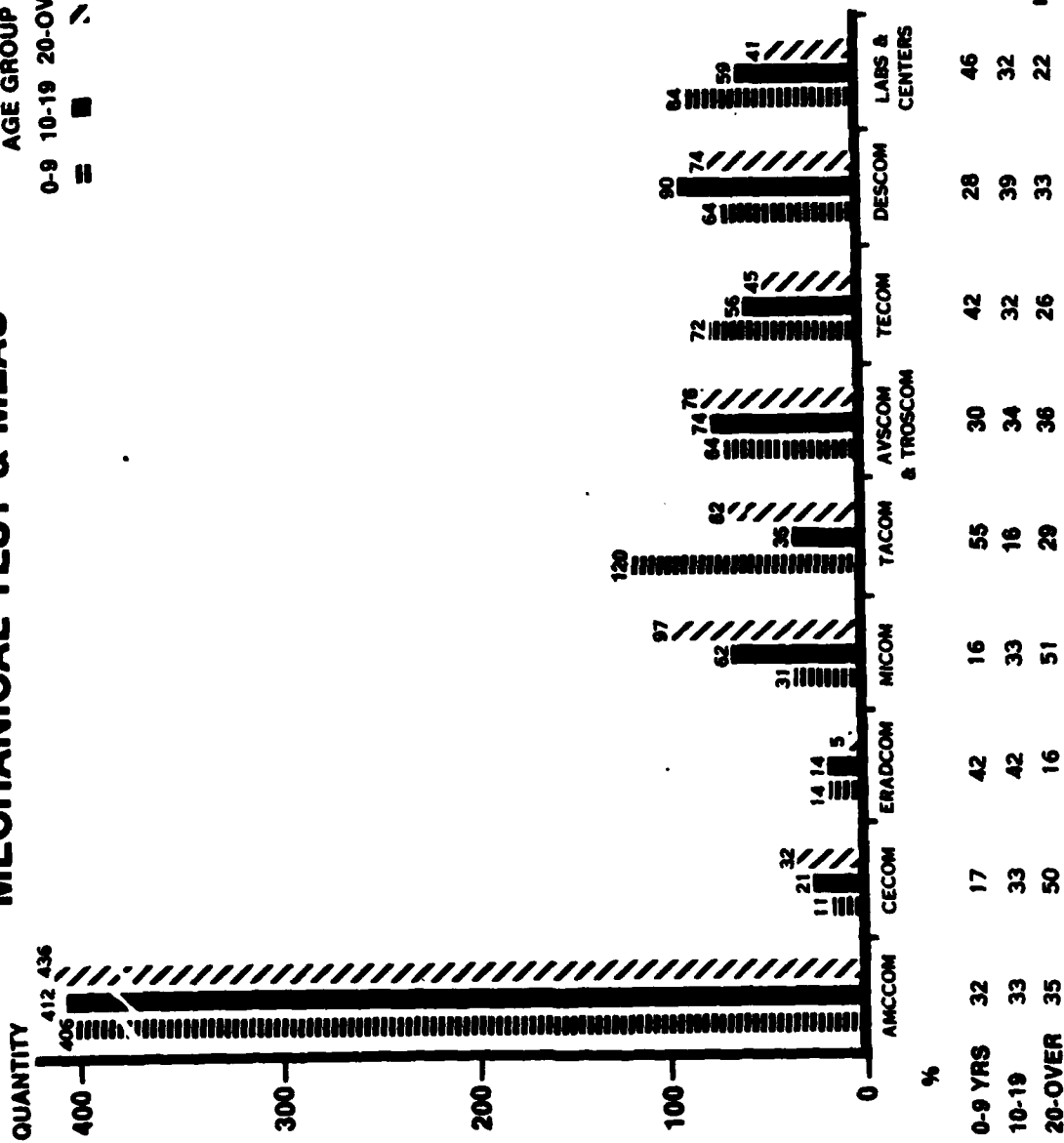


FIGURE III-5

<u>Type</u>	<u>Figure</u>	<u>Page</u>
METALCUTTING	III-6	3-8
WELDING	III-7	3-9
METALFORMING	III-8	3-10
HEAT TREAT AND FURNACES	III-9	3-11
MECHANICAL TESTING AND MEASURING	III-10	3-12

The percentage of metalcutting equipment that exceeds useful service life varies from 27 percent, or 34 items, being used by ERADCOM to 74 percent, or 1,080 items controlled by TACOM. However, AMCCOM has the most equipment, 4,771 items, or 61 percent, that exceed useful service life.

Welding equipment which exceeds useful service life varies from 8 percent, or two items, belonging to ERADCOM, to 56 percent, or 18 items controlled by CECOM. DESCOM and AMCCOM have the most items exceeding useful service life with 42 and 60 items respectively.

TACOM has the highest percent of metalforming equipment which exceeds useful service life with 82 percent, or 77 items. ERADCOM has only 8 percent, or one item, exceeding useful service life. AMCCOM has the greatest quantity, 1,135 items, exceeding useful service life, which is 63 percent of their items.

AMCCOM has 247 items of heat treating equipment and furnaces that exceed useful service life, more than any other command within DARCOM. ERADCOM and DESCOM, with six and eighteen percent respectively, have the lowest percent exceeding useful service life. TECOM and TACOM, have the highest, with 43 percent of their items exceeding useful service life.

AMCCOM has 397 items of mechanical testing and measuring equipment, or 32 percent, which exceeds useful service life. This is the most items for a command within DARCOM. The percentage exceeding useful service life for this type varies from 15 percent, or five items for ERADCOM, to 49 percent, or 91 items, for MICOM.

# ACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE METAL CUTTING

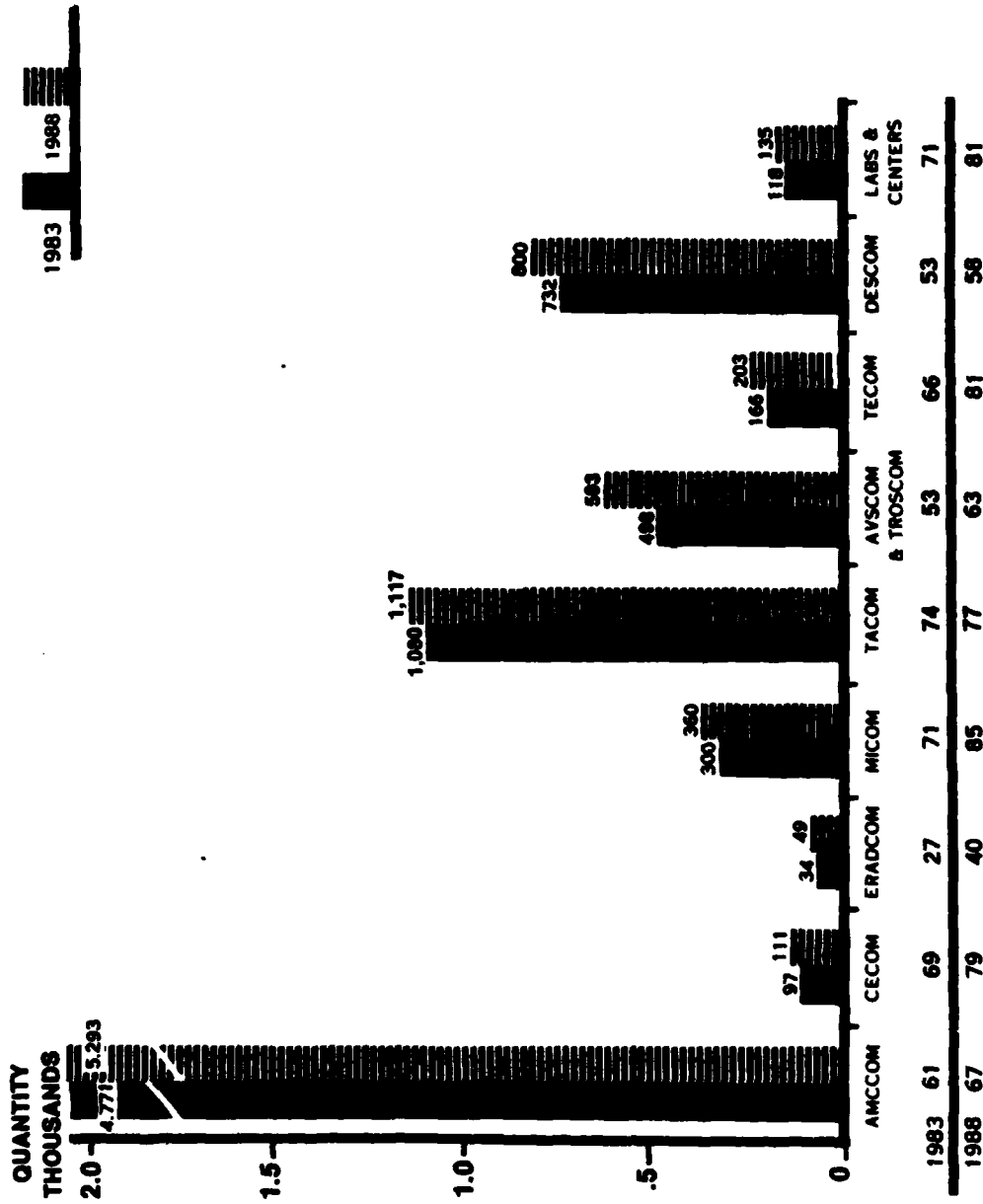


FIGURE III-4

# ACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE WELDING

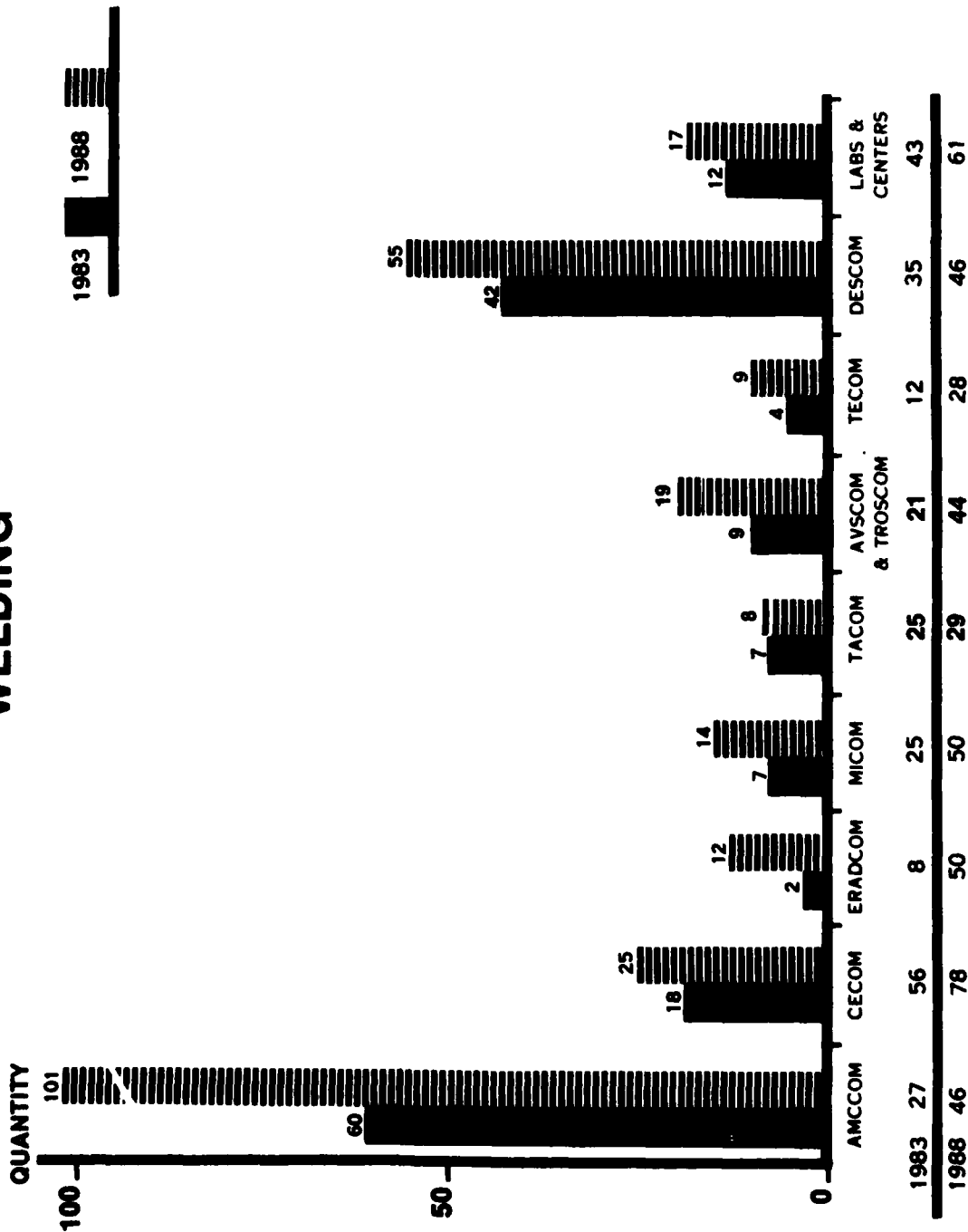


FIGURE III-7

# ACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE METAL FORMING

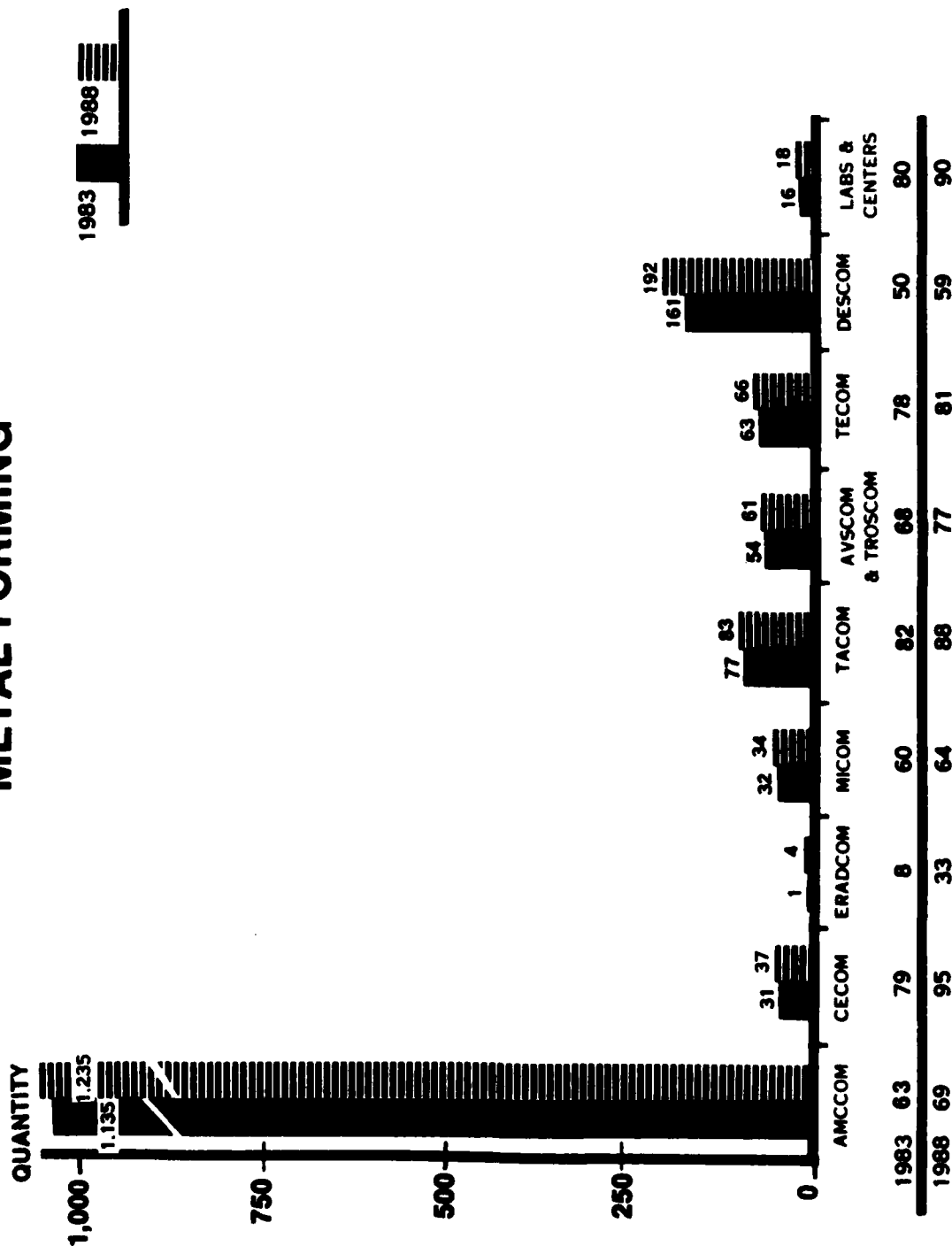


FIGURE III-8

# ACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE HEAT TREAT & FURNACES

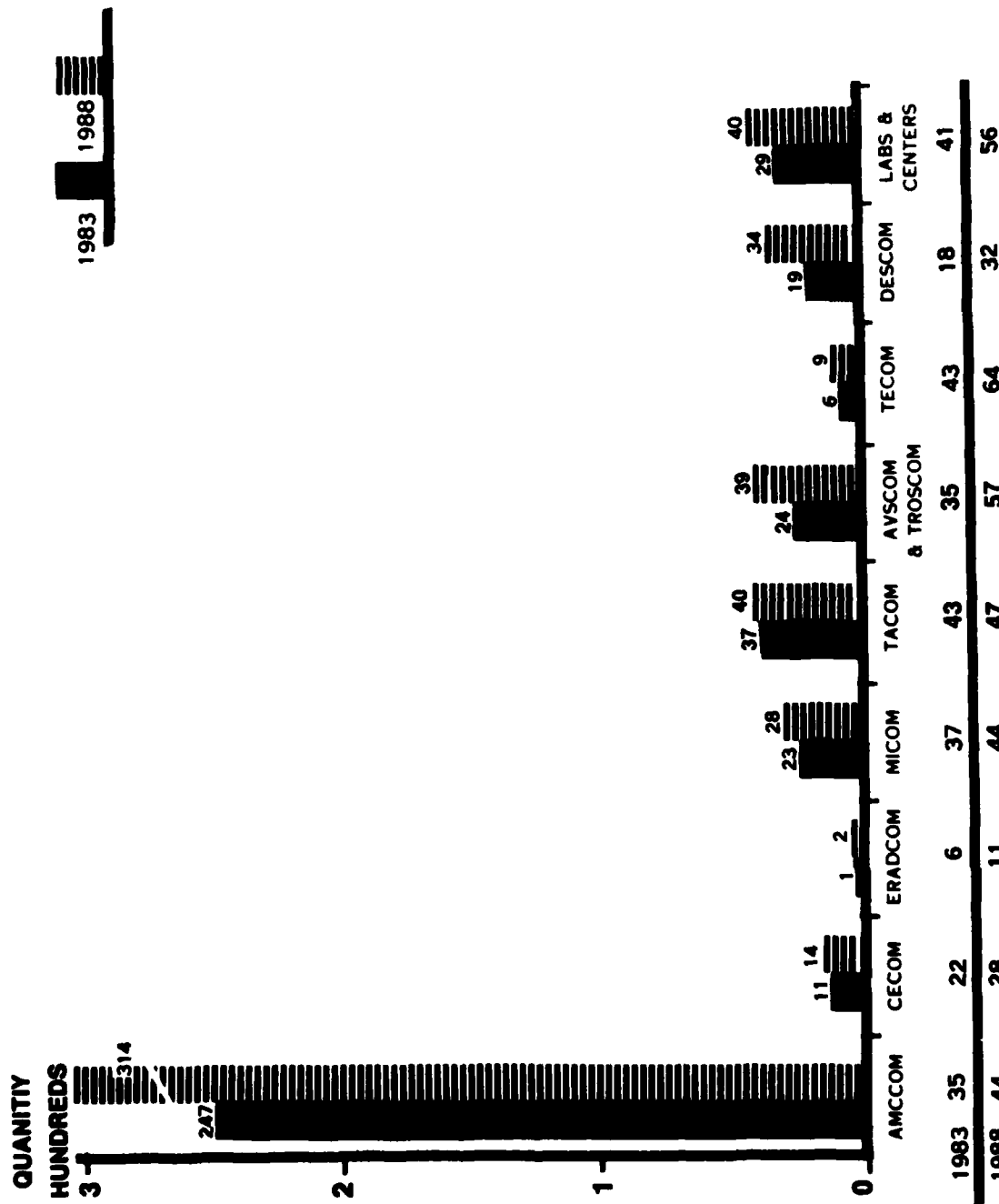


FIGURE III-9

# ACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE MECHANICAL TEST & MEASURE

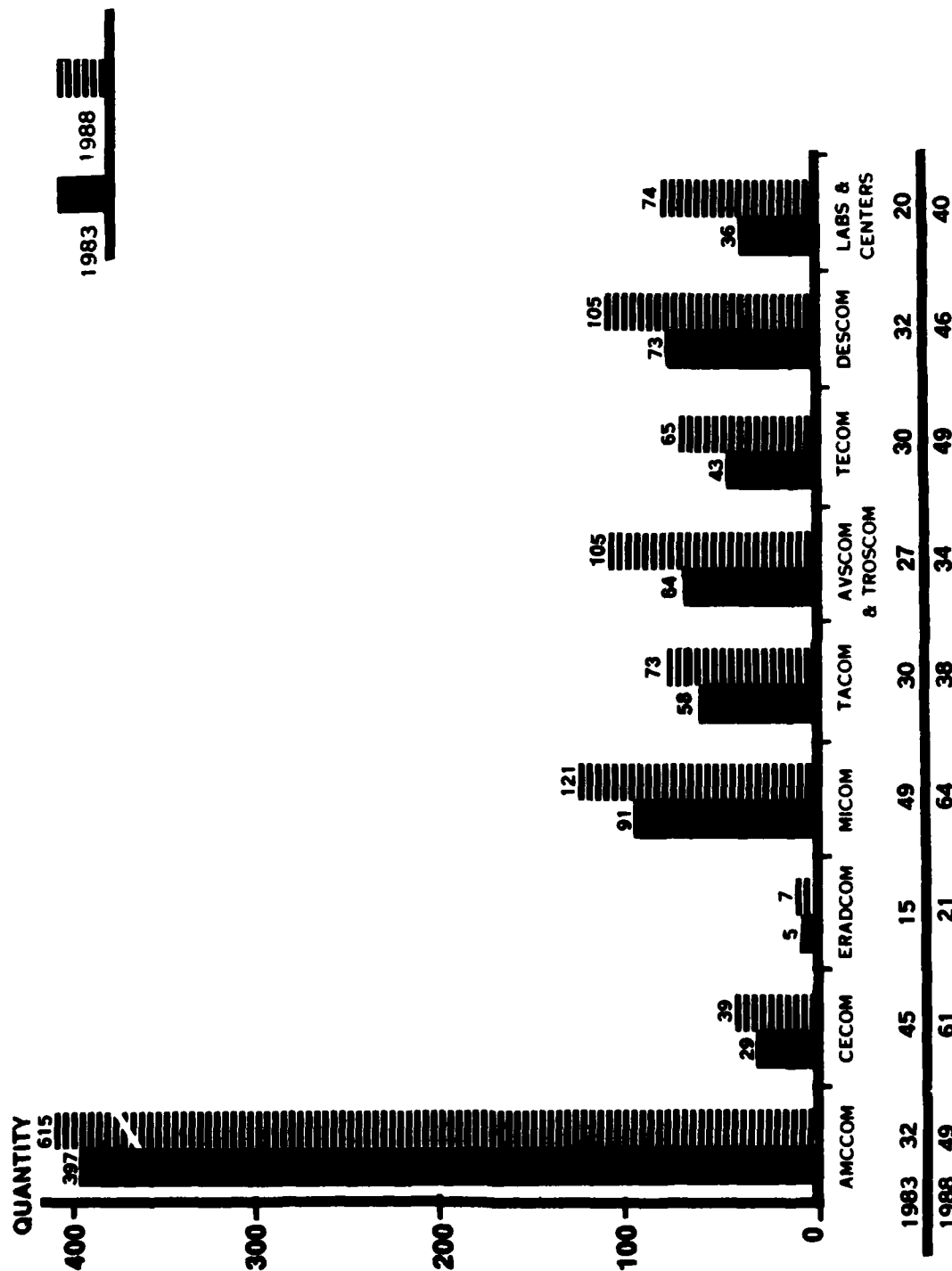


FIGURE III-10

## INACTIVE EQUIPMENT

Age Distribution (Vintage). The age distribution for each of the four types of equipment is shown in the following figures:

<u>Type</u>	<u>Figure</u>	<u>Page</u>
METALCUTTING	III-11	3-14
WELDING	III-12	3-15
METALFORMING	III-13	3-16
HEAT TREAT AND FURNACES	III-14	3-17
MECHANICAL TESTING AND MEASURING	III-15	3-18

As might be expected, the inactive equipment being retained by DARCOM in plant equipment packages (PEP's) has a much older age profile than active equipment.

The bulk of the metalcutting equipment is over 20 years old, varying from 85 percent for TSARCOM, to 99 percent for TACOM. However, AMCCOM controls much more of this equipment, with TACOM a distant second. Significantly, 87 percent of AMCCOM's 7,260 items, and 99 percent of TACOM's 1,512 items are over 20 years old.

AMCCOM has the most welding equipment with 126 items, and TACOM is second with 4. Forty-three percent of AMCCOM's items and 50 percent of TACOM's items are over 20 years old. TSARCOM's only item is over 20 years old.

Metalforming equipment is predominantly over 20 years old. Eighty-nine percent of AMCCOM's items and 93 percent of TACOM's items are over 20 years old. AMCCOM controls the bulk of this inactive equipment, 1,998 items, followed by TACOM with 15 items.

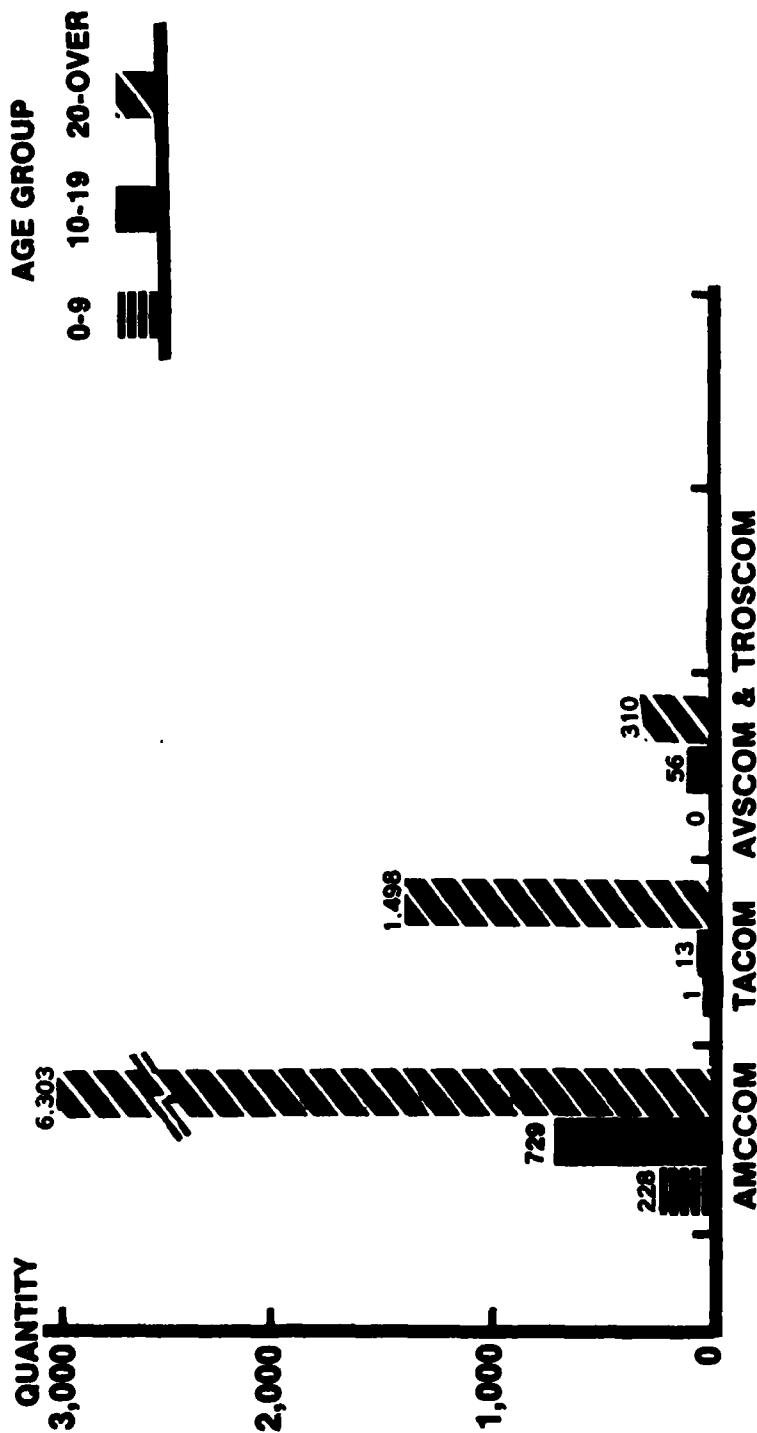
AMCCOM has by far the most heat treating equipment and furnaces; 443 items, or 66 percent over 20 years old. However, 77 percent of TACOM's 22 items are over 20 years old.

ARRCOM has the bulk of the mechanical testing and measuring equipment that is being retained. Forty-six percent of AMCCOM's equipment, or 148 items, is over 20 years old. Ninety-five percent, or 42 items, belonging to TACOM are over 20 years old. Four of the eight items controlled by TSARCOM are over 20 years old.

Useful Service Life. The quantity and percentage of each of the five types of equipment that exceed useful service life are shown in the following figures:

<u>Type</u>	<u>Figure</u>	<u>Page</u>
METALCUTTING	III-16	3-20
WELDING	III-17	3-21
METALFORMING	III-18	3-22
HEAT TREAT AND FURNACES	III-19	3-23
MECHANICAL TESTING AND MEASURING	III-20	3-24

# INACTIVE EQUIPMENT VINTAGE METAL CUTTING



## PERCENT

0-9 YRS	0	0	0
10-19	10	1	15
20-OVER	87	99	85

FIGURE III-11

# INACTIVE EQUIPMENT VINTAGE WELDING

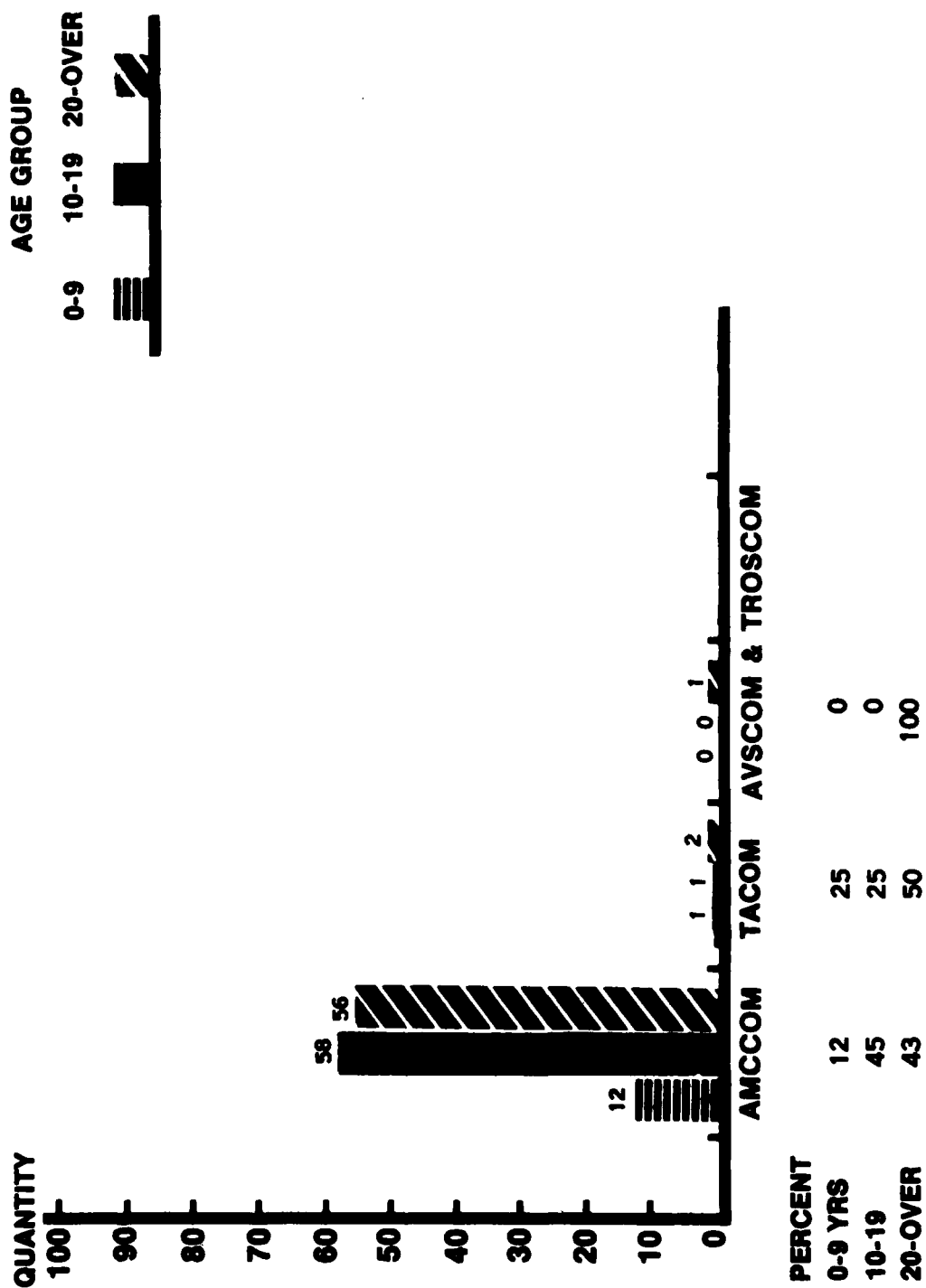


FIGURE III-12

# INACTIVE EQUIPMENT VINTAGE METAL FORMING

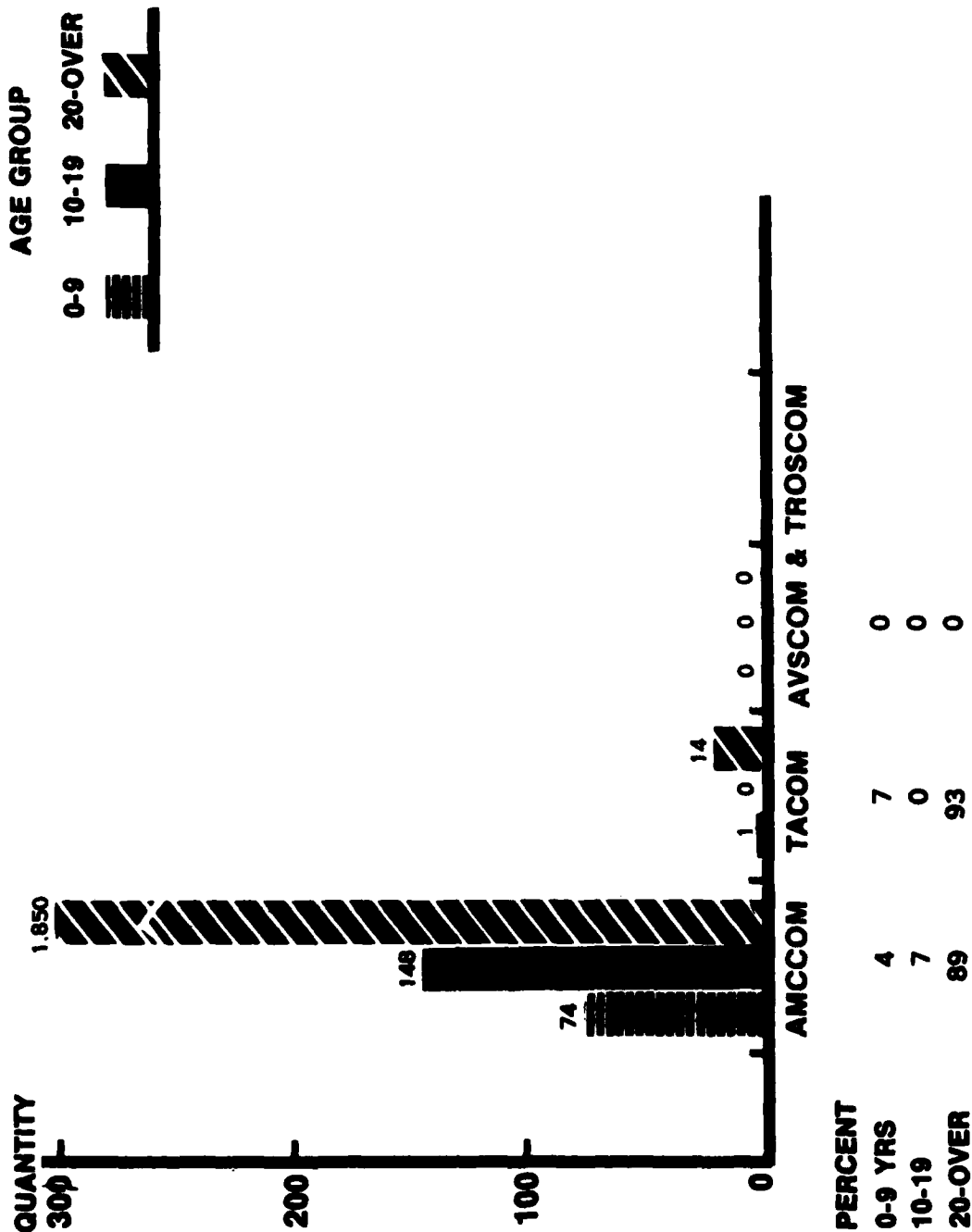


FIGURE III-13

# INACTIVE EQUIPMENT VINTAGE HEAT TREAT & FURNACES

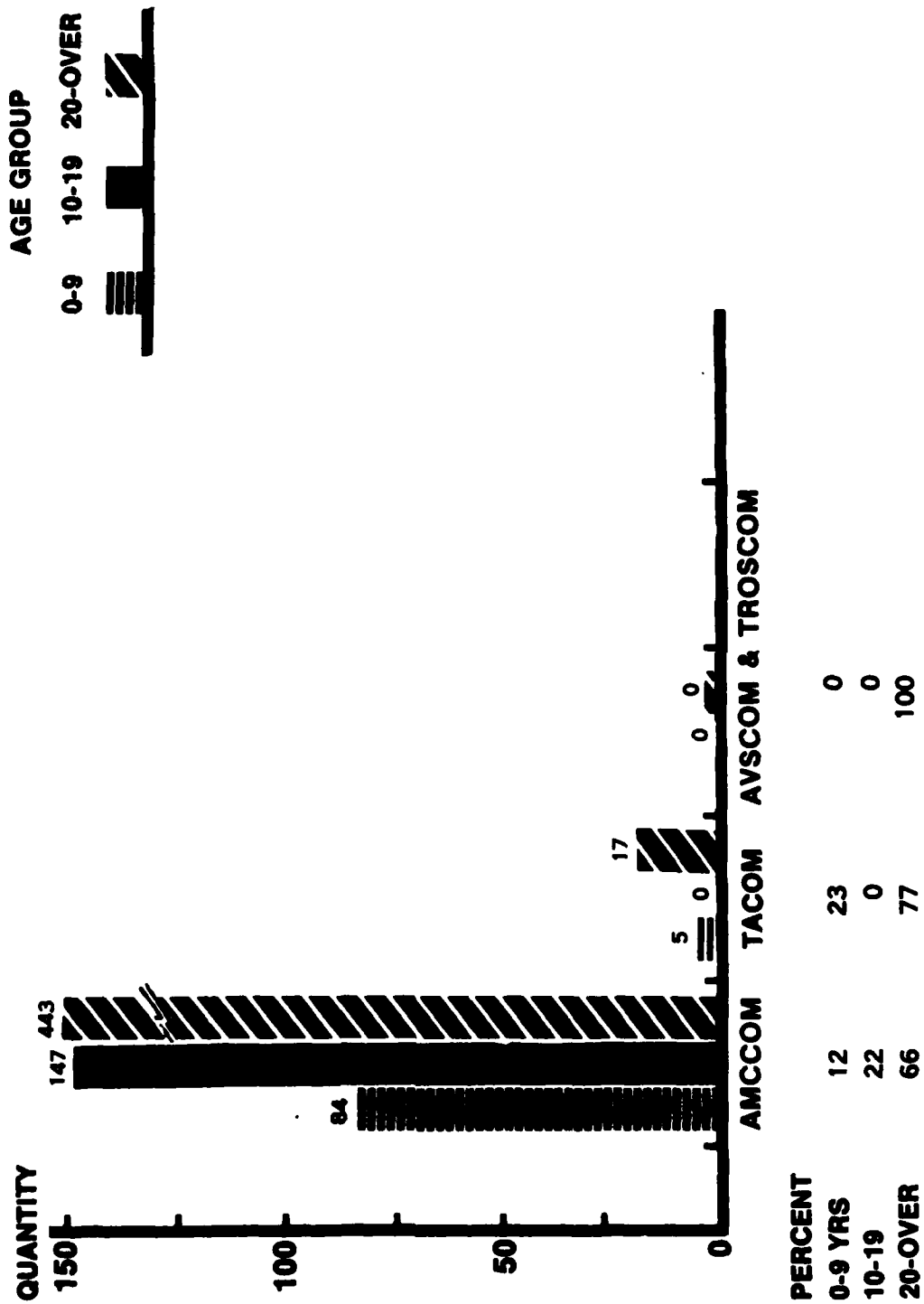
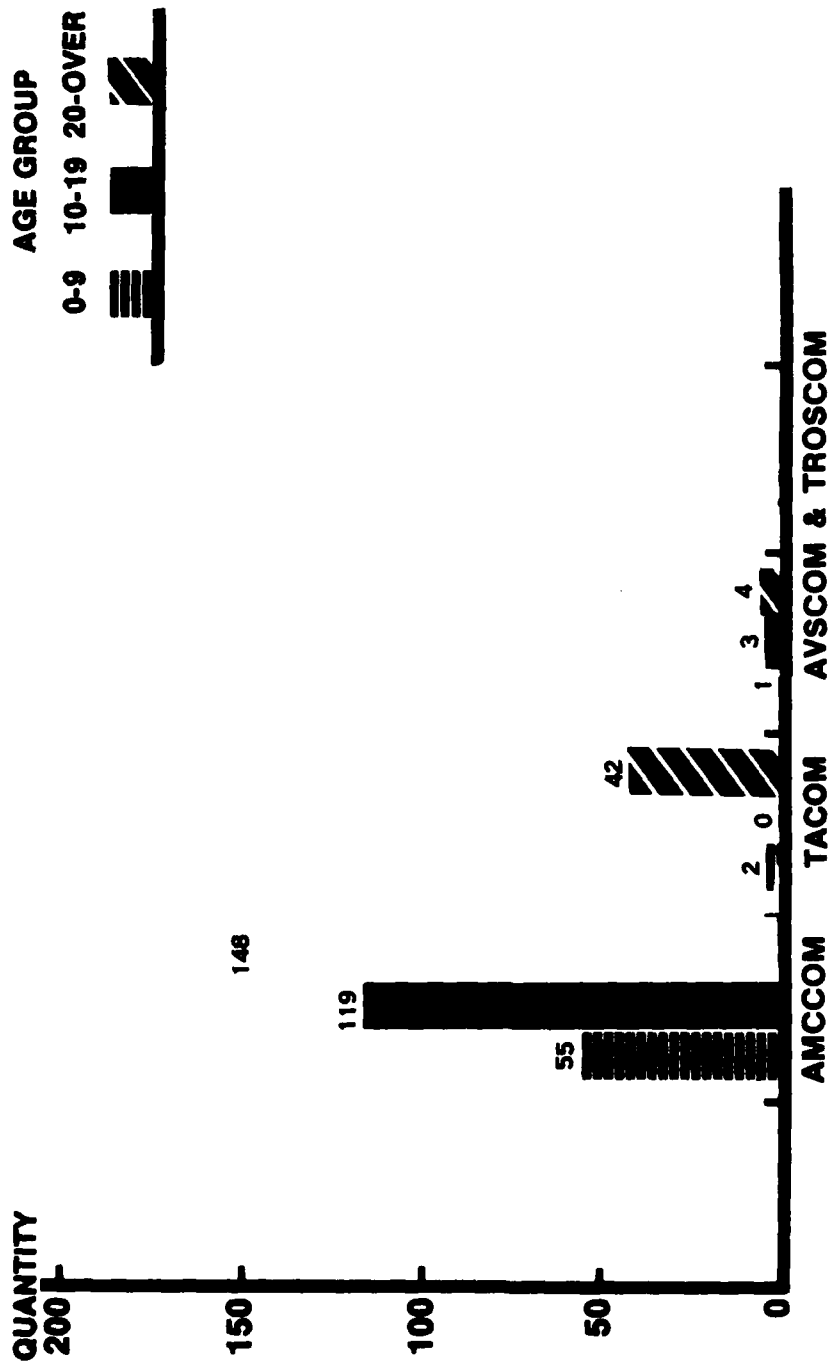


FIGURE III-14

# INACTIVE EQUIPMENT VINTAGE MECHANICAL TEST & MEAS



PERCENT  
0-9 YRS  
10-19  
20-OVER

17 5 12  
37 0 38  
46 95 50

FIGURE III-15

Useful service life is heavily dependent on use which is not directly related to the age of inactive equipment. Therefore, a comparison of equipment age to useful service life for inactive equipment is of limited value.

AMCCOM and TACOM have almost all of the inactive equipment that exceeds useful service life.

TACOM has the greatest percentage of equipment exceeding useful service life. AMCCOM, however, has approximately five times the equipment controlled by TACOM. TSARCOM has only small amounts of equipment that exceed useful service life compared to AMCCOM and TACOM.

# INACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE METAL CUTTING

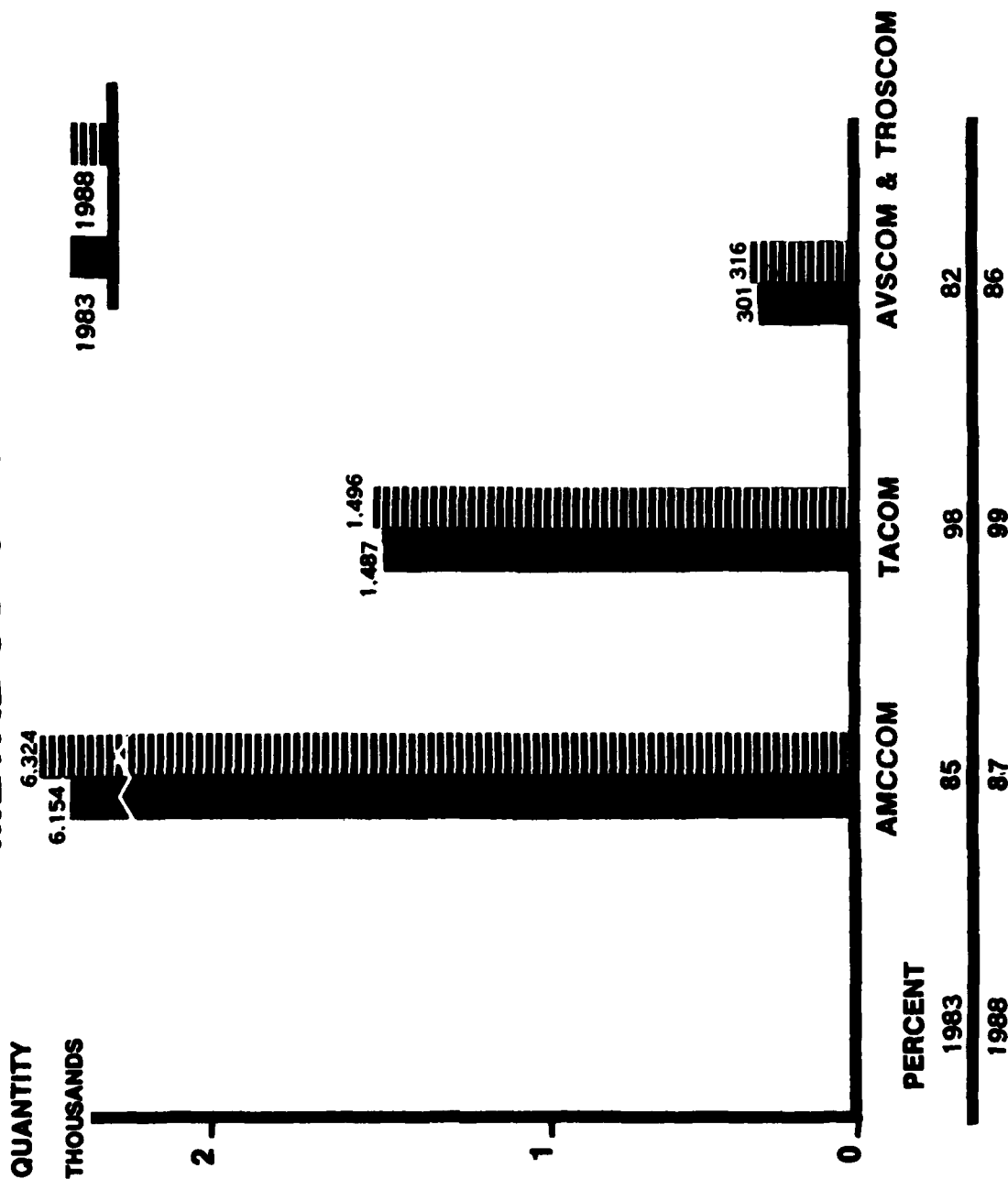


FIGURE III-16

# INACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE

## WELDING

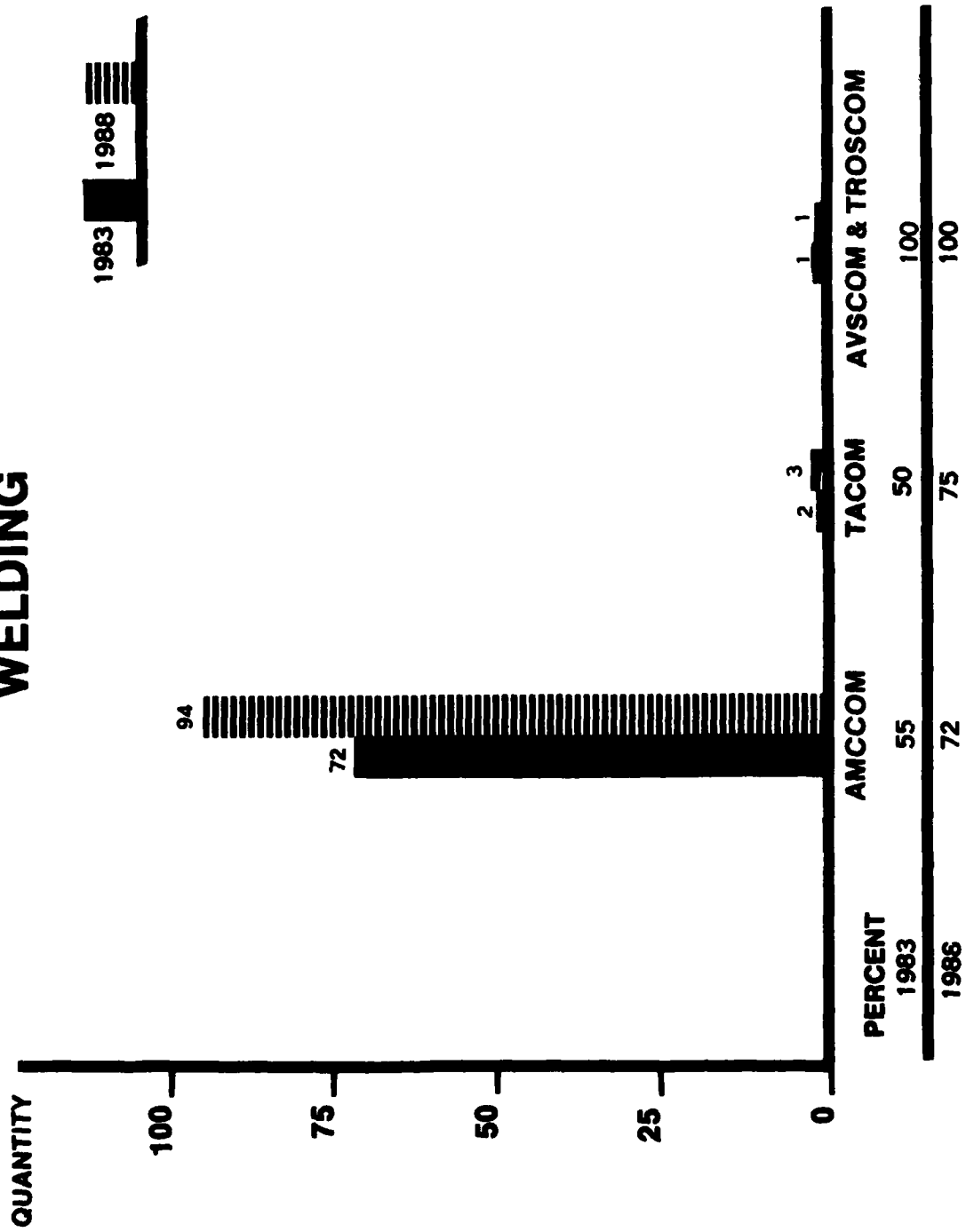


FIGURE III-17

# INACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE METAL FORMING

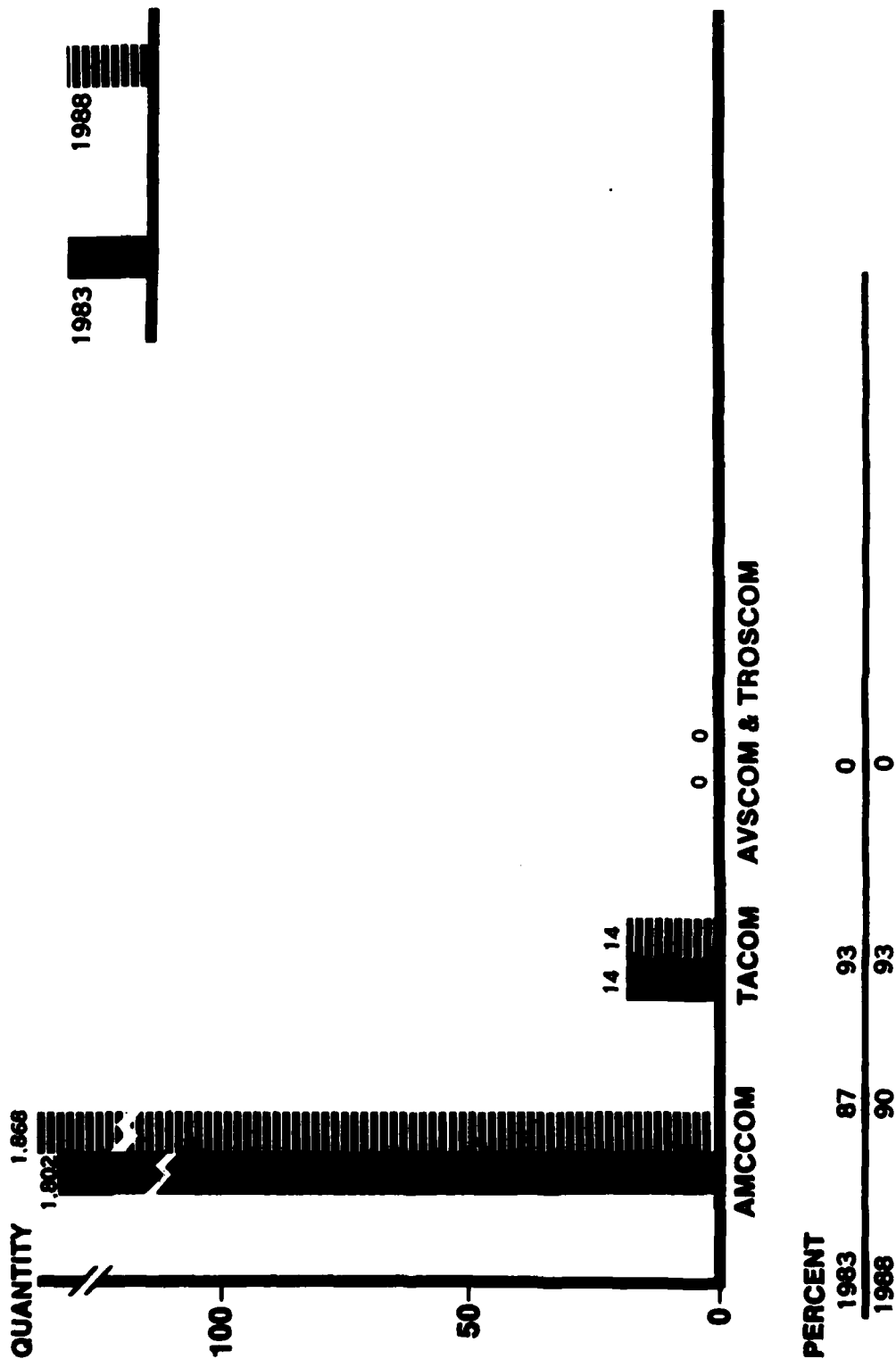


FIGURE III-16

# INACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE HEAT TREAT & FURNACES

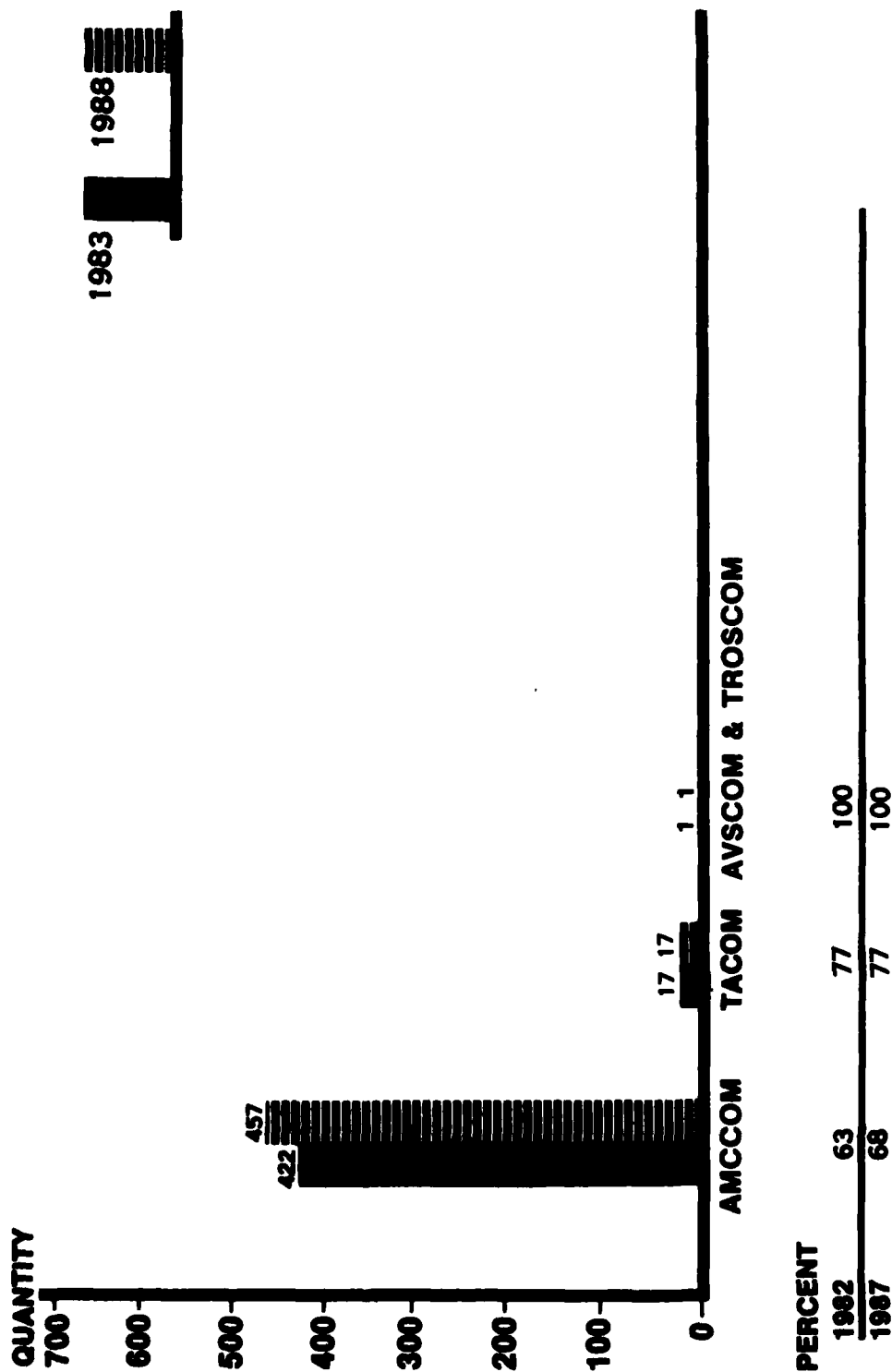


FIGURE III-19

# INACTIVE EQUIPMENT QUANTITY & PERCENT EXCEEDING USEFUL SERVICE LIFE MECHANICAL TEST & MEASURE

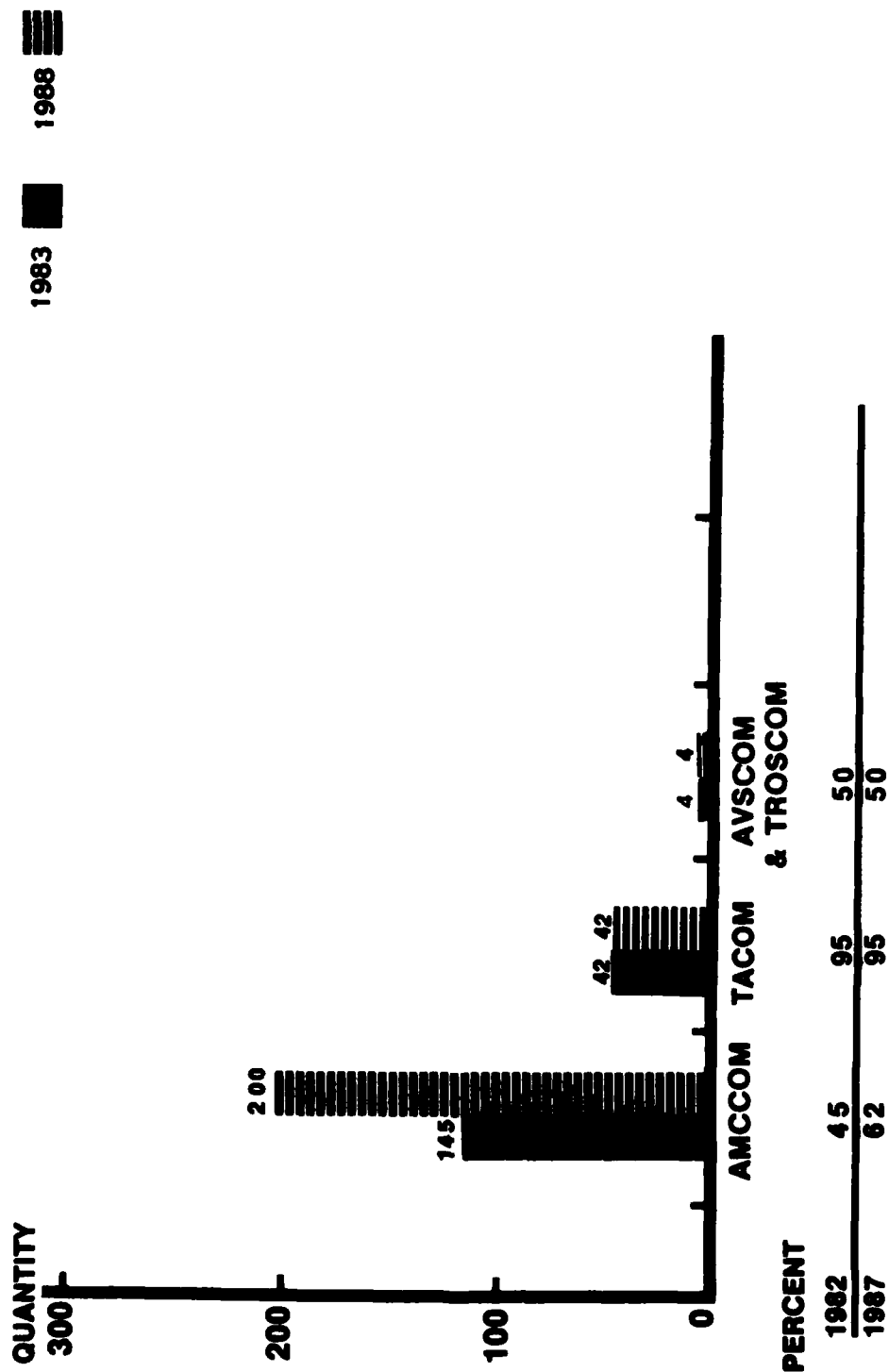


FIGURE III-20

## SECTION IV

### NUMERICAL CONTROL (NC)

Numerical control (NC) is available in eight classes of metalworking equipment owned by the Army. These classes are: boring, drilling, lathes, milling, machining centers, punching, grinding, and bending/forming. The Army inventory of this equipment is shown in Figure IV-1. Boring machines, lathes, and machining centers make up 78.2 percent of the inventory, or 686 items. Punching, grinding and bending/forming machines represent only 2.7 percent of the inventory, or 23 items.

Numerically controlled machines make a significant contribution to the production capacity of the industrial base and represent a sizeable investment. The numerical control inventory of the Army consists of 877 items with an acquisition cost of \$216,334,244. Only one item is not controlled by DARCOM. The distribution of the NC inventory is shown in Figure IV-2. Government-owned/Government-operated (GOGO) facilities control 35 percent, or 306 items. Of these, 6 percent or 53 items are subject to intermittent use, but remain in place in support of the currently assigned mission. Government-owned/contractor-operated (GOCO) facilities control 18 percent, or 157 items. Also, contractor-owned/contractor operated (COCO) facilities control 40 percent, or 355 items which are classified as Government furnished equipment. The remaining 46 percent, or 404 items, are assigned to plant equipment packages (PEPs) for use in mobilization production. The significant increase in the number of PEP items resulted from items still in use but assigned to PEP's through status code 1B.

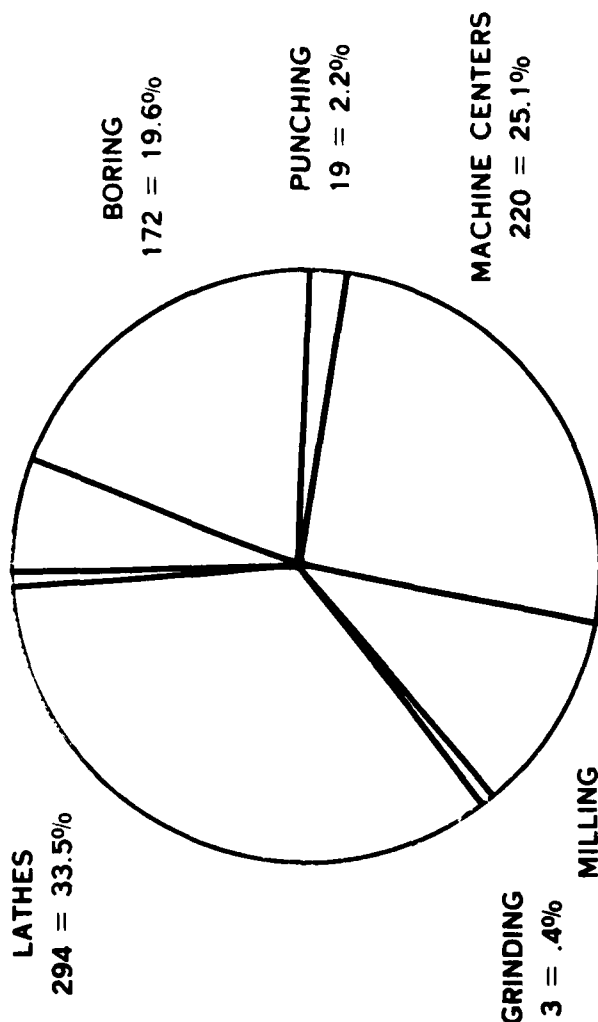
The trend of the inventory of numerically controlled equipment is shown in Figure IV-3. An increasing trend characterizes the inventory, especially since 1978. The disproportionate increase in acquisition cost shown in 1978 is attributable to the addition of the rotary forge at Watervliet Arsenal at a cost of \$6,749,185. The average cost of numerical control equipment has continued to increase at a rapid rate to \$246,675.

The source of the data for numerical control equipment is the DIPEC SP-50 Report as of 27 Jan 84.

# NUMERICAL CONTROL INVENTORY BY CLASS

BENDING & FORMING  
1 = 0.1%

DRILLING  
51 = 5.8%



ACTIVE INACTIVE INT. USE (3H)	BORING		DRILLING		LATHES		MILLING		MACHINING		PUNCHING		GRINDING		BENDING & FORMING		TOTAL
	(3411)		(3413)		(3416)		(3417)		(3408)		(3445)		(3415)				
	152		39		59		97		201		15		3		1		767
	13		5		18		11		12		0		0		0		59
	7		7		17		9		7		4		0		0		51
TOTALS	172		51		294		117		220		19		3		1		877

FIGURE IV-1

# NUMERICAL CONTROL INVENTORY QUANTITY AND USE

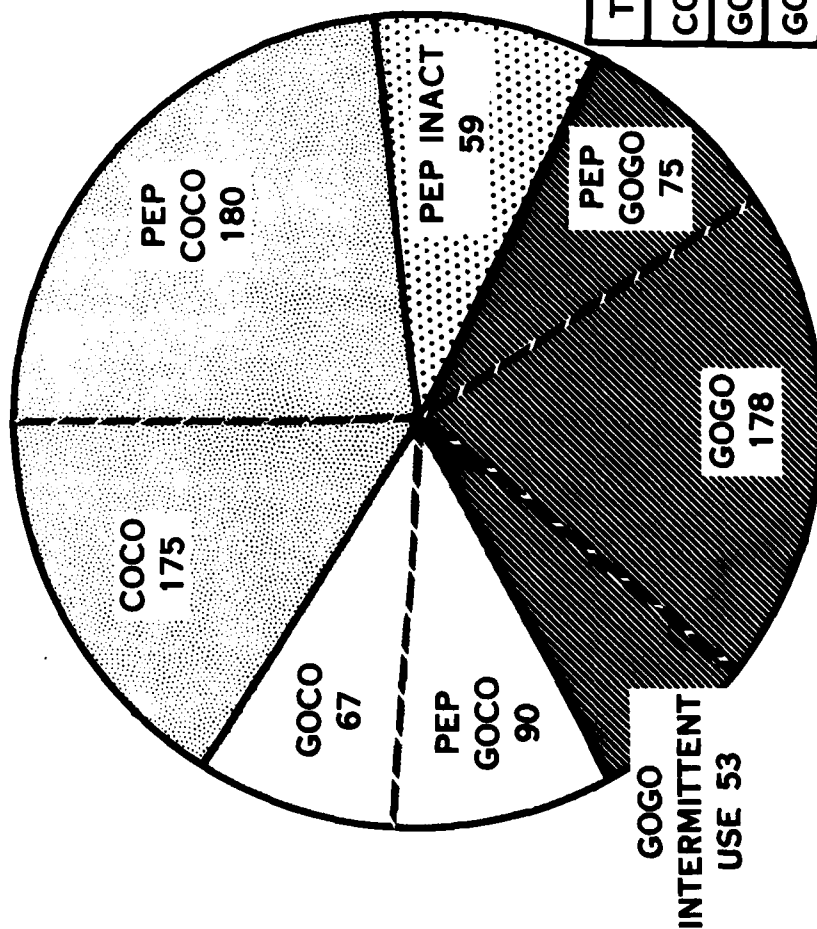
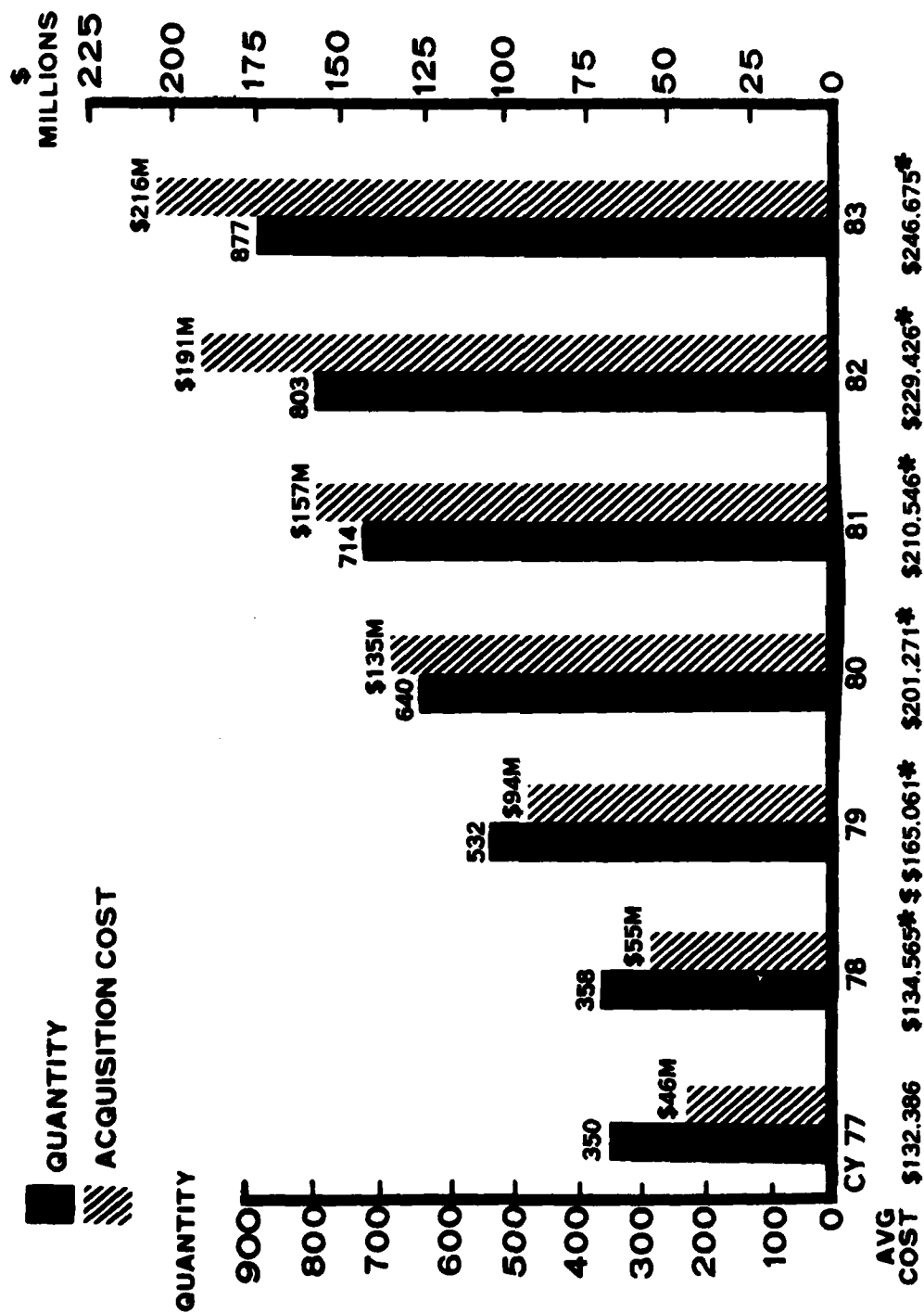


FIGURE IV-2

# INVENTORY TRENDS NUMERICAL CONTROL EQUIPMENT



NOTE: \*AVERAGE COST DOES NOT INCLUDE THE ROTARY FORGE AT WATERVLIET ARSENAL WITH A COST OF \$6,749,185.

FIGURE IV-3

## SECTION V

### REPLACEMENT DATA

#### REPLACEMENT COSTS

The projected replacement costs were extracted from the Army Industrial Equipment Data Base, and are based on current comptroller supplied replacement factors. The data base and the replacement factors were compiled by the Industrial Base Engineering Activity. The estimated cost of the rotary forge at Watervliet Arsenal was not included in the graph.

#### LEAD TIMES

Lead time is the period between which the order is received by the manufacturer, and the machine is received by the purchaser. Lead time is a built in characteristic of the machine tool industry, and is dependent on many factors which include the size and complexity of the machine, the individual manufacturer's characteristics, and the business cycle. For example, standard machines, as well as those in stock, require less lead time than custom built machines, which must be designed and constructed from scratch. Furthermore, with an increase in features and sizes, comes a greater lead time. Lead time is often company specific. Some companies are more efficient or they may be operating under full capacity, both of which shorten lead time. The machine tool industry is very cyclical. In slack periods, machines are delivered relatively quickly. However, in prosperous times, a back log can arise which can double or triple lead time.

Combined, these factors makes lead time estimation very difficult. Furthermore, a constantly changing market will invalidate lead time estimates quickly. However, metalcutting and metalforming machines will generally have a longer lead time under any conditions. Welding and Testing/Measuring machines will generally be the shortest, and heat treating machines will usually fall in between.

Several tool manufacturers from each category of machines was interviewed concerning their lead times. In addition, the Arsenal Operations Directorate, Rock Island Arsenal, Rock Island, provided lead times for actual purchases in each of the five categories. Our lead time estimates are a combination of these two elements.

# RANGE OF REPLACEMENT COSTS FOR IPE

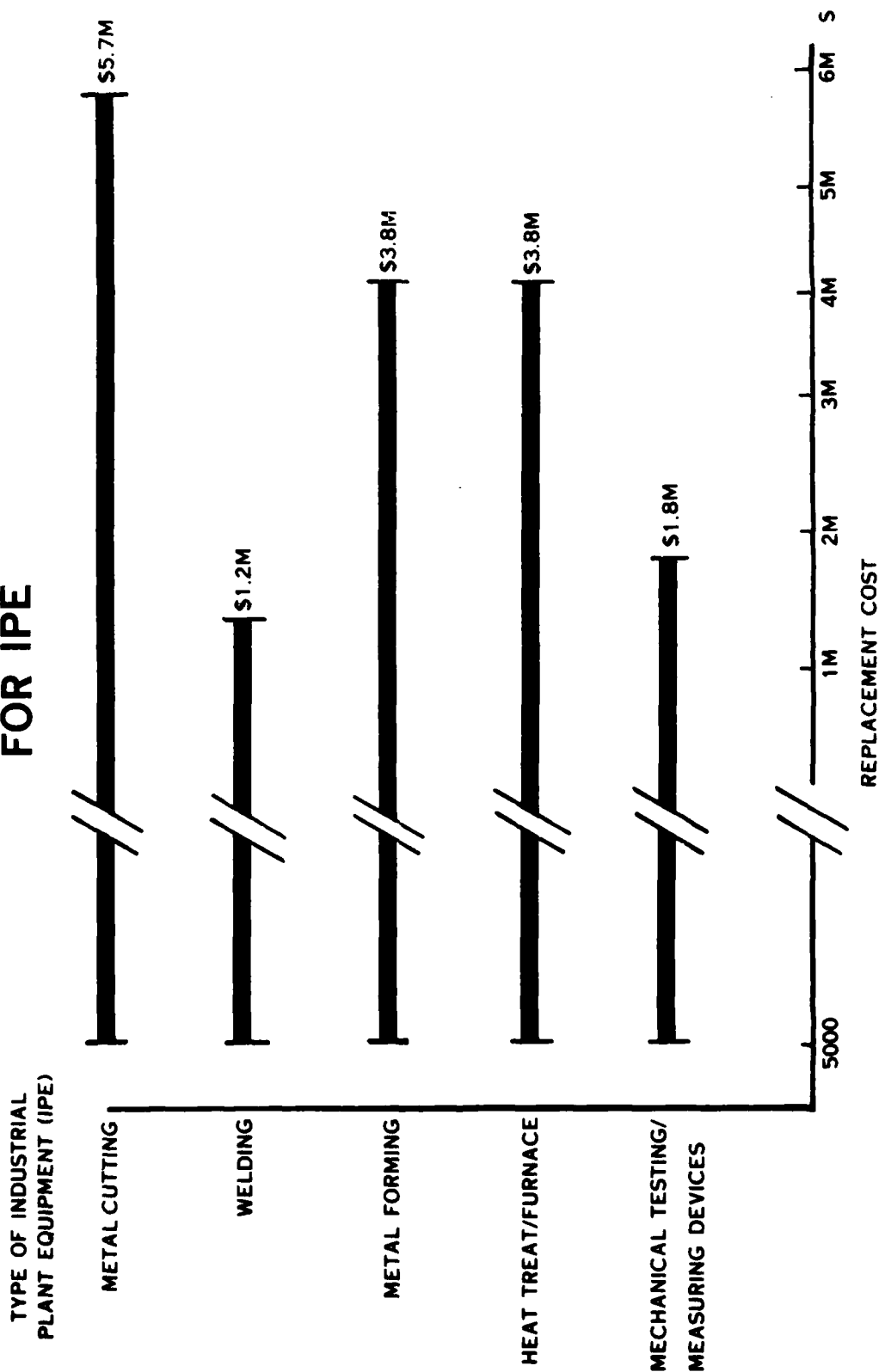
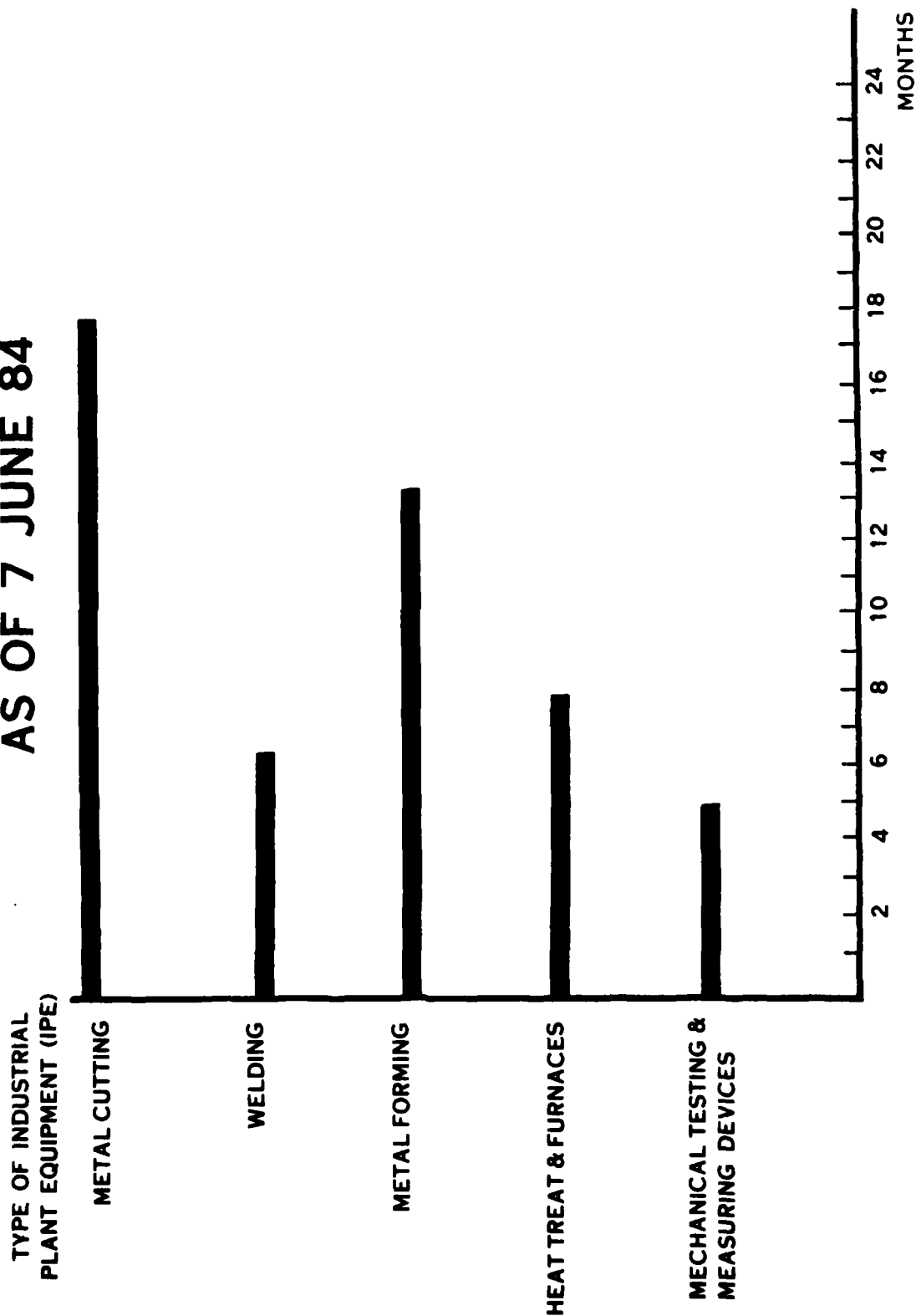


FIGURE V-1

# **RANGE OF LEAD TIMES FOR IPE AS OF 7 JUNE 84**



ESTIMATED LEAD TIME  
FIGURE V-2

## APPENDIX A

Illustrations of Types of Industrial Plant Equipment (IPE)

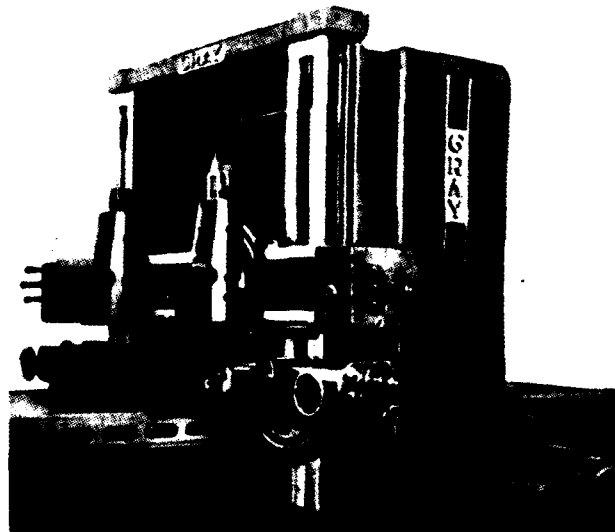
with

Federal Supply Classes (FSC)

### METALCUTTING

#### FSC

- 3405 Saw and Filing Machines
- 3408 Machining Centers and  
Way Type Machines
- 3410 Electrical and Ultrasonic  
Erosion Machines
- 3411 Boring Machines
- 3412 Broaching Machines
- 3413 Drilling and Tapping  
Machines
- 3414 Gear Cutting and Finishing  
Machines
- 3415 Grinding Machines
- 3416 Lathes
- 3417 Milling Machines
- 3418 Planers and Shapers
- 3419 Miscellaneous Machine Tools



72" x 72" x 20"  
PLANNER

### WELDING

#### FSC

- 3431 Electric Arc Welding Equipment
- 3432 Electric Resistance Welding  
Equipment
- 3433 Gas Welding, Heat Cutting and  
Metalizing Equipment
- 3436 Welding Positioners and  
Manipulators
- 3438 Miscellaneous Welding Equipment

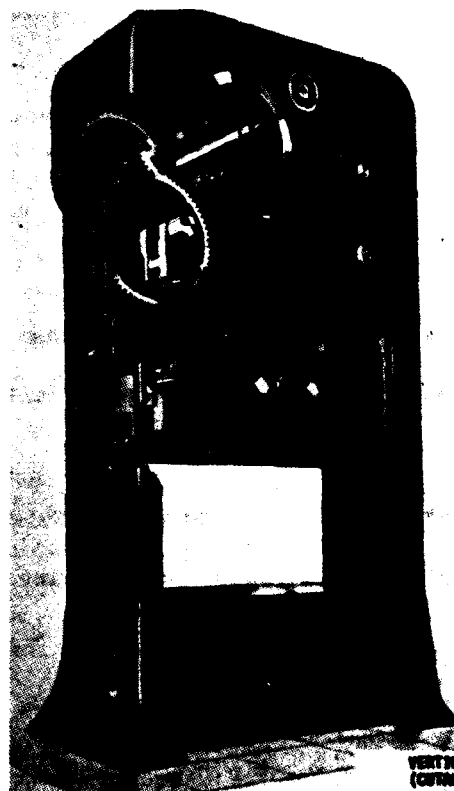


ENGINE DRIVEN  
ARC WELDER

## **METAL FORMING**

### **FSC**

- 3422     Rolling Mills and Drawing  
         Machines
- 3441     Bending and Forming Machines
- 3442     Hydraulic and Pneumatic Presses,  
         Power Driven
- 3443     Mechanical Power Presses,  
         Power Driven
- 3444     Manual Presses
- 3445     Punching and Shearing Machines
- 3446     Forging Machinery and Hammers
- 3447     Wire and Metal Ribbon Forming  
         Machines
- 3448     Riveting Machines

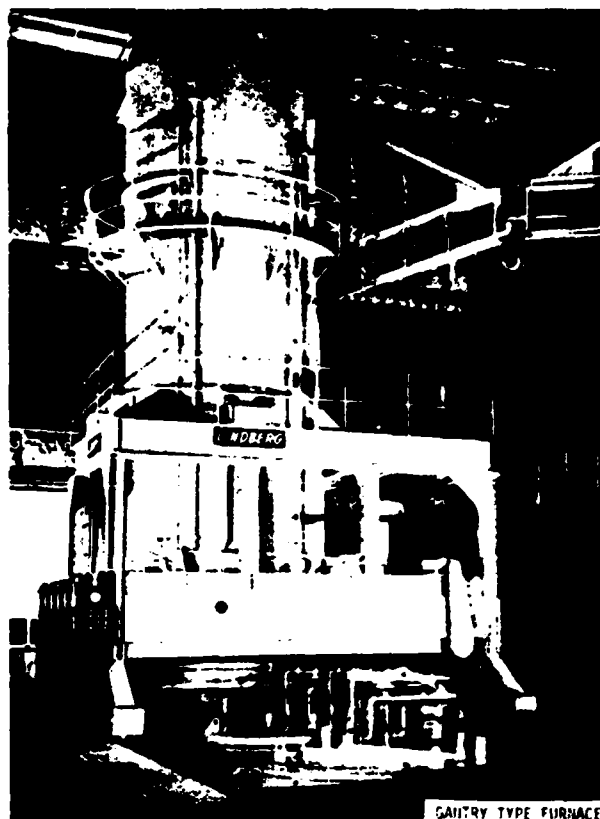


VERTICAL PRESS  
(CUMMINS VIEW)

## **HEAT TREAT AND FURNACES**

### **FSC**

- 3424 Metal Heat Treating and  
Nonthermal Treating  
Equipment
- 4430 Industrial Furnaces, Kilns,  
Lehrs, and Ovens

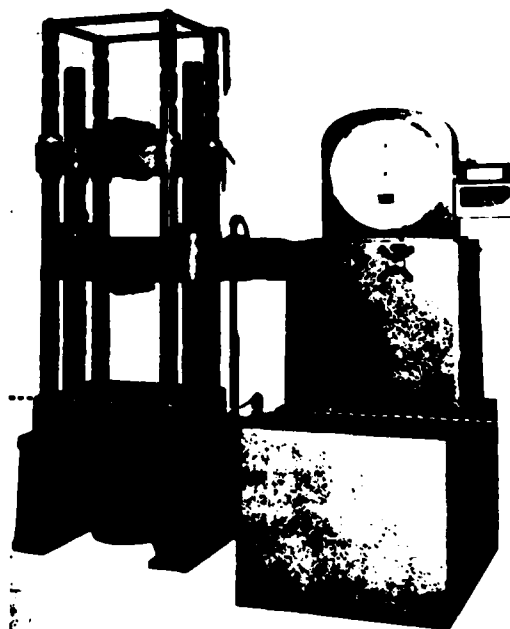


GANTRY TYPE FURNACE

## **MECHANICAL TESTING AND MEASURING DEVICES**

### **FSC**

- 6635 Physical Properties Testing  
Equipment



UNIVERSAL TESTING MACHINE

END

FILMED

1-84

DTIC